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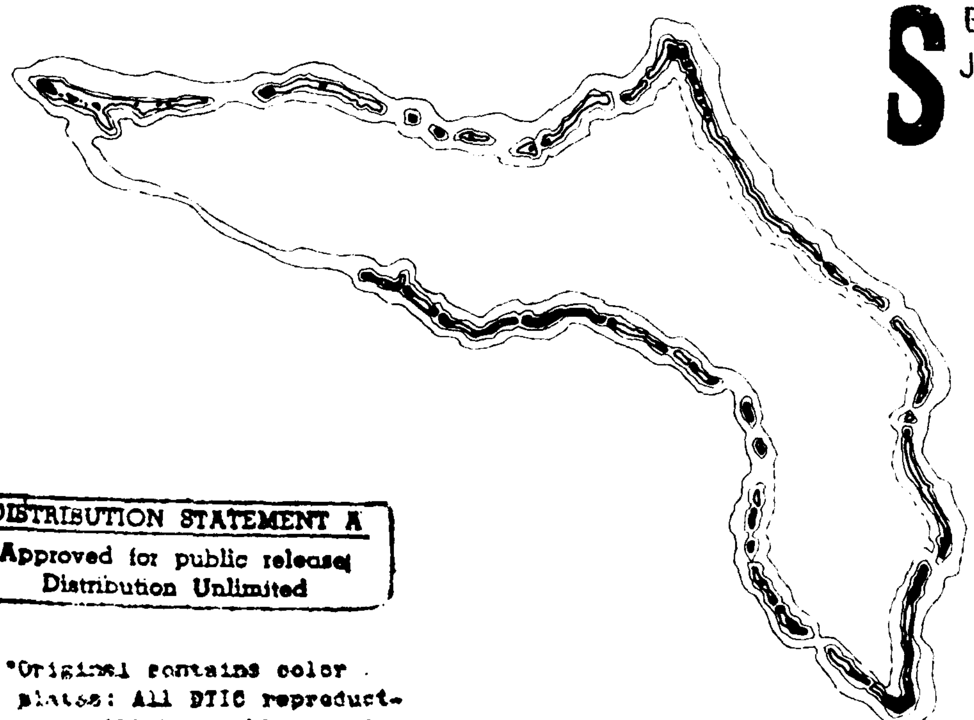
Draft Environmental Impact Statement

Proposed Actions at U.S. ARMY KWAJALEIN ATOLL



U.S. Army Strategic Defense Command

SDC

June 1989

If you wish to comment on the DEIS, please write to:

U.S. Army Strategic Defense Command
Attention: CSSD-H-SSP (LTC Ronald A. Keglovits)
P.O. Box 1500
Huntsville, Alabama 35807-3801
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Sincerely,

Samuel N. Liberatore
Colonel, U.S. Army
Deputy for Operations

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY STRATEGIC DEFENSE COMMAND - HUNTSVILLE
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

June 12, 1989

TO: All Interested Government Agencies, Public Groups, and Individuals

Gentlemen/Ladies:

We are providing you a copy of the Draft Environmental Impact Statement (DEIS) for the proposed actions at the U.S. Army Kwajalein Atoll (USAKA). The proposed action would include continuation of current activities at USAKA and planned non-Strategic Defense Initiative (SDI) activities as well as proposed SDI activities.

The U.S. Army Strategic Defense Command will conduct two public hearings as part of the environmental impact analysis process. They are scheduled as follows:

Date: Thursday, July 13, 1989 (Majuro time)
Time: 7:00 p.m.
Location: Majuro Court House, Majuro, RMI

Date: Thursday, July 13, 1989 (USAKA time)
Time: 7:00 p.m.
Location: Elementary School, Ebeye, RMI

The public hearings and public comment period offer an opportunity for government officials and concerned citizens to provide input to the Army's decisionmaking process. As part of the format for the public hearings, the Army will address the current activities at USAKA, the planned non-SDI activities, and the proposed SDI activities. The presentation will also address the environmental impact analysis process used to prepare the DEIS and environmental consequences. Following the presentations, interested individuals will be given an opportunity to present their comments. Speakers will be requested to limit their comments to five (5) minutes.

The close of the public comment period on the DEIS is August 7, 1989.

The comments received during the public hearings, as well as written comments received during the public comment period, will be used to develop the final environmental impact statement which is scheduled to be published in October 1989.

LEAD AGENCY: U.S. Army Strategic Defense Command

COOPERATING AGENCIES: Strategic Defense Initiative Organization
U.S. Army Corps of Engineers

TITLE OF THE PROPOSED ACTION: Provide test range facilities and support services at U.S. Army Kwajalein Atoll for ongoing and Strategic Defense Initiative activities.

AFFECTED JURISDICTION: U.S. Army Kwajalein Atoll, Republic of the Marshall Islands

ADDITIONAL INFORMATION: U.S. Army Strategic Defense Command
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U.S. Army Strategic Defense Command

DOCUMENT DESIGNATION: Draft Environmental Impact Statement

ABSTRACT: The purpose of the Proposed Action is to conducts tests and collect data in support of continuing research, development, and operational missions; operational space track missions; and Strategic Defense Initiative (SDI) research, development, test, and evaluation (RDTE) activities.

Three alternatives are considered in this Draft Environmental Impact Statement (DEIS). The No-Action Alternative includes the ongoing activities at USAKA. The Proposed Action includes installation and testing of SDI sensing/tracking equipment and interceptor missile systems. Five construction projects in support of base operations are also included. Finally, the DEIS examines a Change of Duration Alternative that implements the Proposed Action over a longer period of time.

The DEIS examines the environmental impacts of each alternative. Where impacts were found to be potentially significant, mitigation measures are identified. Key topics addressed by the DEIS include land and reef areas, water resources, air quality, noise, biological resources including endangered species, cultural resources, socioeconomics, transportation, utilities, and range safety.

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ACRONYMS

Acronym	Definition
ABM	Antiballistic missile
ac	Alternative current
AFB	Air Force Base
Al_2O_3	Aluminum oxide
ALCOR	ARPA-Lincoln C-Bank Observables Radar
ALTAIR	ARPA Long Range Tracking and Instrumentation Radar
AMI	Airline of the Marshall Islands
ANSI	American National Standards Institute
AOA	Airborne Optical Adjunct
AR	Army Regulation
ARE	Aerothermal Reentry Experiment
ARK	Analysis of the Relocation of Kwajalein
ARPA	Advanced Research Projects Agency
ATV	Advance technology validation
BMAR	Backlog of maintenance and repair
BOA	Broad ocean area
BOD	Biological oxygen demand
CCT	Command Control Transmitter
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CINCPACFLT	Commander in Chief Pacific Fleet
CO	Carbon monoxide
COE	Corps of Engineers
dB	Decibel
dBA	A-weighted decibels
DDT	Dichloro-diphenyl-trichloroethane
DEIS	Draft Environmental Impact Statement
Dem/Val	Demonstration and validation
DFM	Diesel Fuel Marine
DNL	Day-night sound level
DOD	Department of Defense
EA	Environmental assessment
EDX	Exoatmospheric Discrimination Experiment
EIS	Environmental impact statement
EMR	Electromagnetic radiation
EOD	Explosive ordnance disposal
EPA	Environmental Protection Agency
ERIS	Exoatmospheric Reentry Vehicle Interceptor Subsystem
ERPA	Evader Replica Penetration Aid
ESQD	Explosive safety quantity distance

Acronym	Definition
FAA	Federal Aviation Administration
FFOV	Full field of view
FONSI	Finding of no significant impact
FTV	Functional technology validation
FY	Fiscal year
GBR-X	Ground-Based Radar-Experimental
GHz	Giga Hertz
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm	Gallons per minute
GPS	Global Positioning System
GSTS	Ground-Based Surveillance and Tracking System
HALO/IRIS	High Altitude Learjet Observatory and Infrared Instrumentation System
HCl	Hydrogen chloride
HEDI	High Endoatmospheric Defense Interceptor
HF	High frequency
HITS	Hydro-Acoustic Impact Timing System
HOE	Homing Overlay Experiment
ICBM	Intercontinental ballistic missile(s)
ILS	Instrument landing system
ISC	Industrial Source Complex
JP-5	Jet petroleum
KADA	Kwajalein Atoll Development Agency
KALGOV	Kwajalein Atoll Local Government
kHz	Kilo Hertz
KMR	Kwajalein Missile Range
KREMS	Kiernan Reentry Measurements Site
KRSS	Kwajalein Range Safety System
KV	Kill vehicle
kW	Kilowatt
kWh	Kilowatt hour
LCM	Landing craft materiel
LCU	Landing craft utility
LFOV	Limited field of view
LWIR	Long wave infrared radar
MAB	Missile assembly building
MAC	Military Airlift Command
MAST	Maneuvering Systems Technology
met	Meteorological
MHz	Mega Hertz
MM I	Minuteman I
MM II	Minuteman II

Acronym	Definition
MM III	Minuteman III
MMH	Monomethyl hydrazine
MMS	Multistatic Measurement System
MMW	Multimeter Wave Radar
MoGas	Motor vehicle gasoline
mph	Miles per hour
MRTFB	Major Range and Test Facility Base
MSW	Municipal solid waste
MSX	Mid-Course Sensors Experiment
MW	Megawatts
mW/cm^2	Milliwatts per square centimeter
N_2O_4	Nitrogen tetroxide
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NO_x	Nitrogen oxide
NOTAM	Notice to airmen
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric turbidity units
OAMP	Optical Aircraft Measurement Program
ODRT	Orbital Debris Radar Test
OSHA	Occupational Safety and Health Act
PCB	Polychlorinated biphenyls
PEL	Permissible Exposure Limit
PK-OT	Peacekeeper Operational Testing
PK-RAIL	Peacekeeper Rail Garrison
PM10	Particulate matter less than 10 microns in size
PMRF	Pacific Missile Range Facility
POL	Petroleum oil lubricant
ppm	Parts per million
R&D	Research and development
RADOTS	Recording Automatic Digital Optical Trackers
RCRA	Resource Conservation and Recovery Act
RDTE	Research, development, test, and evaluation
REEDM	Rocket Exhaust Effluent Dispersion Model
Rf	Radio frequency
RMI	Republic of the Marshall Islands
RV	Reentry vehicle
SABIR	Space-Based Interceptor (see also SBI)
SBI	Space-Based Interceptor (see also SABIR)
SCT	Satellite Communications Transmitter
SDC	Strategic Defense Command
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SDR	Splash Detection Radar
SDS	Strategic Defense System
SDWA	Safe Drinking Water Act
SICBM	Small Intercortinental Ballistic Missile(s)

Acronym	Definition
SLBM	Sea-launched ballistic missile(s)
SLEC	Security and law enforcement contractor
SMILS	Sonobuoy Missile Impact Location System
SO	Sulfur oxide
STARS	Strategic Target System
STIL	Short Time Interval Launch
STS	Space Transportation System
TDY	Temporary duty
TOSCA	Toxic Substances Control Act
TRADEX	Target Resolution and Discrimination Experiment
TU	Turbidity units
UPH	Unaccompanied personnel housing
USAF	United States Air Force
USAKA	United States Army Kwajalein Atoll
USASDC	United States Army Strategic Defense Command
USFWS	United States Fish and Wildlife Service
USMC	United States Marine Corps
USN	United States Navy
VFR	Visual flight rule
VHF/UHF	Very high frequency/ultra high frequency
W/kg	Watts per kilogram
WSMC	Western Space and Missile Center

EXECUTIVE SUMMARY

INTRODUCTION

The Proposed Action is to provide test range facilities and support services at U.S. Army Kwajalein Atoll (USAKA) for continuing research, development, operational missions, operational space track missions, and Strategic Defense Initiative (SDI) activities. USAKA has served as a Department of Defense (DOD) Major Range and Test Facility Base (MRTFB) since the late 1950s.

This draft environmental impact statement (DEIS) is prepared in compliance with the National Environmental Policy Act (NEPA) and its implementing regulations, DOD Directive 6050.1, and Army Regulation (AR) 200-2, Environmental Effects of Army Actions. The relationship between the United States and the Republic of the Marshall Islands is currently governed by the Compact of Free Association Act of 1985, Public Law 99-239 dated January 14, 1985.

The scope of this DEIS includes an analysis of impacts from ongoing operations in order to provide a baseline for the evaluation of future SDI activities and related construction.

As part of the EIS process, scoping meetings were held at Majuro and Ebeye in the Republic of the Marshall Islands and in Honolulu, Hawaii, during March 1988. Concerns were expressed about adverse impacts on the physical environment, public health and safety, and social and economic conditions.

ALTERNATIVES

This DEIS considers three alternatives:

- No-Action Alternative. This alternative is the continuation of USAKA mission activities. It includes missile launches for test flights, meteorological data gathering, radar calibration, the sensing and tracking of incoming reentry vehicles for DOD test programs, and space surveillance. Test programs are supported by radar and optical sensing equipment, telemetry, communications, and other technical range support facilities. Base operations include all the activities required to support a community of almost 3,000 people in an isolated location--transportation, utilities, housing, community support, maintenance, and repair services.

- Proposed Action. This alternative considers SDI testing at USAKA together with ongoing and planned non-SDI activities. The proposed SDI testing includes the launch of target and interceptor missiles from Meck, Omelek, and Roi-Namur Islands. Other tests involve the sensing and tracking of reentry vehicles through the use of existing radars and a major new radar facility (the ground-based radar), as well as other sensing and tracking instruments (both existing and new). Meck Island, previously used for other programs, will be rehabilitated for SDI launches. Omelek Island, now used primarily for meteorological rocket launches, will be the site of new launch facilities. Construction on Kwajalein includes a desalination plant, family housing, and unaccompanied personnel housing. On Roi-Namur, it includes a sewage treatment plant and document control facility.

- Change of Duration Alternative. This alternative differs from the Proposed Action only in that testing of one SDI activity would be delayed for 5 years and testing of the ground-based radar would be delayed for 2 years. The purpose of considering the Change of Duration Alternative is to determine whether some environmental impacts could be lessened by rescheduling some SDI testing to reduce the peak levels of population increase.

An alternative was considered that would reduce or eliminate missile testing in the Pacific Ocean region. USAKA's location is a critical factor for missile testing because it provides security and a high degree of safety. A Pacific Ocean missile test range is also critical for tracking the NASA space shuttle and other United States and foreign space objects. Because missile flight testing is an essential part of developing and maintaining a credible defense system, this alternative was determined to be unreasonable.

Moving the USAKA facilities and functions to another location in the Pacific Ocean was also considered unreasonable because of the investment in infrastructure at USAKA and because of the long delays such an extensive relocation would cause in SDI development and decisionmaking.

AFFECTED ENVIRONMENT

Kwajalein Atoll is a crescent-shaped coral reef that encloses the world's largest lagoon. In contrast to the vastness of its water area, the land area of the atoll is only 5.6 square miles. The environment of Kwajalein Atoll is the product of millions of years of natural processes, followed by a brief but critical period of human activity. During

World War II, Kwajalein Atoll was subjected to severe air, land, and sea bombardment. Today, USAKA is a key facility in the Western Test Range, one of two national test ranges permitted to carry out testing under the 1972 Anti-Ballistic Missile Treaty. With some exceptions, noted below, USAKA's environment is healthy.

Water Resources

Abundant rainfall is the primary source of freshwater for plant, animal, and human life. Because the groundwater aquifer is limited, water conservation techniques are a necessary and routine part of life at USAKA. Marine water quality around USAKA islands has generally been satisfactory, except in a few localized areas.

Air Quality and Noise

The air quality is generally good throughout the atoll. USAKA's few stationary sources and motor vehicles present localized air quality impacts.

Noise is usually not a problem except around the power plant on Kwajalein Island. There is an average of two to three rocket launches per month from several of the populated and unpopulated islands of USAKA.

Island Plants and Animals

There is a wide variety of plants, seabirds, shorebirds, and other terrestrial animals on the USAKA islands. The flora are diverse and the fauna abundant.

Marine Biological Resources

Kwajalein Atoll has a large and complex coral reef ecosystem and an ocean environment that is typical of the Western Mid-Pacific region. More than 650 species of marine plants and animals inhabit the atoll and its reef system. Habitat is present for threatened or endangered sea turtles, rare giant clams, and seagrasses.

Archaeological, Historical, and Cultural Resources

Kwajalein Atoll is part of the Republic of the Marshall Islands (RMI) and the USAKA islands are leased by the United States from RMI. Because of its long history of human occupation, there is a probability of finding cultural deposits and remains in locations where there are present-day human activities.

Land Use

At USAKA, a variety of Army and other DOD facilities and activities carry out sensitive missile research, development, and testing. These activities and the services necessary to support them exist in a very small area in which all spatial patterns of land use are closely controlled and efficiently managed.

On Kwajalein Island, for instance, a community of approximately 3,000 people live and work on 748 acres. The scarcity of land on Kwajalein in relation to the numbers of people and the intensity of USAKA activities has forced an efficient and environmentally sound land use pattern.

Socioeconomic Conditions

All of the people at USAKA are either employed in support of the defense mission or are dependents of personnel who are employed in support of the mission. Housing is an issue of concern. USAKA's remote location and extreme environmental conditions make the provision of adequate housing a challenge.

Transportation

Because of Kwajalein's isolation and island geography, marine and air transportation are critical. Facilities are generally adequate although their use, particularly for air service, is heavy.

Utilities

Solid and hazardous materials and waste disposal pose an acute problem at USAKA, as does the provision of an adequate water supply. On Kwajalein and Roi-Namur, utilities include permanent facilities for water supply; wastewater collection, treatment, and disposal; solid waste; hazardous waste disposal; and power generation. For the most part, these facilities are at capacity.

Energy demand and consumption are large because of the numerous defense-related facilities and services and, among other factors, the heavy air-conditioning load.

Range Safety and Electromagnetic Radiation Environment

Range safety is defined as those measures that are established to prevent injury, protect personnel and the general public, and minimize damage to property. It is always a priority at a military test range. At USAKA, its importance is emphasized (more than at most ranges) because USAKA encompasses the takeoff or splashdown zones for some of the most sophisticated weaponry in the nation's arsenal.

Electromagnetic radiation (EMR) is emitted from USAKA's many radars and communications facilities. A well-defined program to protect inhabitants from safety hazards and from EMR is in place at USAKA. The effect of new programs on these systems is, therefore, a part of this DEIS.

The relationship of the human community to the natural environment and resources of Kwajalein Atoll is carefully managed; however, serious problems remain to be solved.

IMPACTS AND MITIGATION

The Proposed Action would accomplish a critical step in the testing of SDI elements, following the schedule established to ensure the timely development of a Strategic Defense System.

Impacts and mitigation measures for the Proposed Action are summarized below. The matrix presented at the end of this summary shows a comparison of the alternatives, their impacts, and mitigations.

- Freshwater. Demands on the Kwajalein groundwater lens would increase, particularly during drought periods. The potential to overpump the groundwater lens would increase the potential for groundwater quality degradation because of saltwater infiltration. The proposed Kwajalein desalination plant would mitigate the increased demands on the groundwater lens system.

- Marine Water Quality. Impacts on marine water quality--because of inadequate solid and hazardous waste management practices, treated sewage effluent at Kwajalein, untreated sewage effluent at Roi-Namur, dredging, and quarrying--would all increase as a result of the higher population and level of activities. Mitigation for impacts that result from sewage, solid waste, and hazardous waste are described in their respective sections.

- Air Quality. The increase in solid waste burning and power plant operations would exacerbate the existing exceedances of air quality standards. The new Power Plant 1A is predicted to contribute to air quality standard exceedances. Air quality impacts could be mitigated by additional air quality controls, reduced power plant operations, increases in stack heights, and installation of a solid waste incinerator with air pollution controls.

- Noise. In addition to the noise impacts of Power Plant 1 described under the No-Action Alternative,

operation of Power Plant 1A would result in a DNL level of about 66 dBA at the nearest noise-sensitive property--slightly above the significance level of 65 dBA. However, the noise level would be completely dominated by noise from existing Power Plant 1. Measuring and installation of exhaust silencers on the power plants, would mitigate noise impacts.

- Island Flora. Construction of a missile launch facility on Omelek, depending on where it is finally sited, could require the removal of parts of one of Omelek's three stands of native trees. Careful siting of the proposed facilities could reduce the number of trees that would have to be removed. Trees that must be removed could be transplanted to other locations.

- Marine Biological Resources. Increased quarrying and dredging would produce short-term, localized, insignificant impacts. The proposed sewage treatment plant on Roi-Namur would reduce impacts to marine life from untreated sewage effluent. To minimize shoreline erosion, quarries would be sited at least 100 feet from the outer reef edge. Harbor improvements at Omelek could cause a localized impact to the rich coral biota near the existing jetty. This impact could be mitigated through careful site planning and construction practices.

- Rare, Threatened, or Endangered Species. Increased operations could put additional pressure on rare giant clams (*T. gigas*) and seagrass beds. As mitigation, USAKA plans to issue a regulation that will be based on RMI Environmental Protection Agency regulations prohibiting the taking of *T. gigas*. Giant clams could be transplanted from areas where they might be damaged by USAKA activities.

- Archaeological/Cultural/Historical. The proposed construction of a launch facility on Omelek could disturb subsurface archaeological resources. The proposed unaccompanied personnel housing at Kwajalein could have an adverse impact on subsurface archaeological resources. Depending on final siting and on construction practices, proposed construction at Kwajalein and Roi-Namur could disturb subsurface historical resources. Increased population and activity on those islands could have an indirect impact on these same resources. Ground-disturbing activities should be planned so that known sites of archaeological, cultural, or

historical resources will be protected. Preconstruction sampling of the Omelek site would determine their extent, nature, and significance. If the proposed facilities cannot be located to avoid a significant site entirely, a preconstruction data recovery program would be appropriate.

- Socioeconomic Conditions. The nonindigenous population at USAKA is expected to increase over the current figure of 2,972, but will not exceed the historical maximum. The population would increase by 403 in 1992 and 1993 and would drop in 1994 to an increment of 315 (excluding temporary construction workers). In 1997, there would be zero population increase. A shortage of family housing units is predicted for the No-Action Alternative and would be further increased by the Proposed Action, even after construction of 130 proposed new family housing units. Unaccompanied personnel housing is projected to be deficient even after construction of 400 proposed new units. USAKA is considering requesting additional funds for housing. Use of substandard trailers will continue.

  Taxes paid to RMI would increase owing to the greater number of construction and operations personnel at USAKA.

- Transportation. The marine transport of equipment and supplies to support the new SDI launch facilities on Meck would require construction of a proposed small craft berthing facility at Meck. Other impacts on marine and ground transportation would be insignificant.

- Utilities. Increased demands on the Kwajalein Island freshwater supply that would result from a larger population would exacerbate both the supply and water quality problems identified for the No-Action Alternative. The proposed desalination plant would mitigate these impacts.

  Increased demands on the wastewater treatment system at Kwajalein Island could result in periodic discharges of excessive suspended solids that would exceed primary treatment criteria. Water conservation, additional biological treatment capacity, and an additional clarifier would mitigate predicted impacts on the Kwajalein Island wastewater treatment system. The proposed package sewage treatment plant on Roi-Namur would eliminate the discharge of untreated sewage.

The increase in population and activity at USAKA would exacerbate already inadequate solid waste management practices. Impacts could be mitigated by constructing facilities and instituting practices that would ensure acceptable disposal. New facilities should include a regulated municipal waste incinerator and sufficient improvements to the existing landfill to meet standards for a regulated sanitary landfill.

The increase in population and activity would worsen already inadequate hazardous materials and waste handling practices. Impacts could be mitigated by constructing new facilities and instituting new procedures. Such facilities would include storage, an industrial furnace, and an acid neutralization unit. PCBs stored at Kwajalein Island should be disposed of and aboveground fuel storage should be upgraded.

Energy consumption would increase, mainly because of the electrical demands of the new ground-based radar. Construction of Power Plant 1A on Kwajalein (now under way) will ensure that adequate generating capacity is available there. Renovation and expansion of the power plant on Meck Island will ensure adequate capacity on that island.

Environmental Resource	No Action		Proposed Action		Change of Duration Alternative	
	Regional[1]	Local[2]	Regional[1]	Local[2]	Regional[1]	Local[2]
Land and Reef Resources	○		○		○	
Groundwater		●		● M		● M
Marine Water Quality		●		● M		● M
Air Quality		●		● m		● m
Noise		●		● m		● m
Island Plants				● m		● m
Island Animals				○		○
Marine Biological Resources	○		○	● m	○	● m
Rare, Threatened, or Endangered Species		●		● m		● m
Archaeological Resources		○		● m		● m
Historical Resources		○		○		○
Land Use						
Population Nonindigenous			○		○	
Marshallese						
Employment Nonindigenous			*		*	
Marshallese						
USAKA Housing	●		● M		● M	
Income/Fiscal Conditions	*		*		*	
Health, Education, Recreation						
Transportation			○		○	
Water Supply		●		● M		● M
Wastewater		●		● M		● M
Solid Waste	●		● m		● m	
Hazardous Materials/Waste	●		● m		● m	
Energy			○		○	
Aesthetics						
Range Safety						
Electromagnetic Radiation						

LEGEND

- ● Significant Negative Impacts
- ○ Insignificant Negative Impacts
- m Potential Mitigation
- M Mitigation as Part of the Alternative
- * Positive Impact

Notes: Blank = No Impact
Please review the text of Section 2.5 for an explanation of the impacts and mitigations summarized here.

[1] Regional Impacts: More than one island and/or large area affected.
[2] Local Impacts: Only one island and/or localized effects expected.

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

COMPARISON OF ALTERNATIVES, IMPACTS, AND MITIGATION

Figure ES-1

Chapter 1
PURPOSE OF AND NEED FOR THE ACTION

1.1 BACKGROUND

U.S. Army Kwajalein Atoll (USAKA), formerly known as Kwajalein Missile Range, is a subordinate command of the U.S. Army Strategic Defense Command (USASDC). USAKA is located in the Republic of the Marshall Islands (RMI), 2,100 nautical miles southwest of Honolulu, Hawaii (Figures 1.1-1 and 1.1-2). The world's largest lagoon is enclosed by Kwajalein Atoll (Figure 1.1-3). It has a surface area of 1,100 square miles.

When the United States began to develop intercontinental ballistic missiles (ICBMs) in the 1950s, a site was needed for testing antiballistic missiles and for studying the reentry characteristics of ballistic missiles systems. Kwajalein Atoll was well suited to these activities because its isolated location provided security and a high degree of safety. During the United States' 30-year history of guided and ballistic missile testing, USAKA has been a primary site for research and development of Army ballistic missile defense systems such as NIKE-ZEUS, NIKE-X, Sentinel/Safeguard programs, and the Homing Overlay Experiment (HOE) interceptor missiles. Since 1964, the range has also continuously supported a variety of Air Force and Navy strategic offensive programs including ICBMs and sea-launched ballistic missiles (SLBMs).

The sensing and tracking facilities used to track ballistic missiles and the location of Kwajalein Atoll near the equator provided an opportunity to enhance the capacity of the United States to track space objects and foreign launches. Thus, in 1984, USAKA's mission was expanded to include a space tracking function. Today, USAKA performs this mission using existing range assets, including radars, optical sensors, and telemetry.

The essential functions performed by USAKA are launching, sensing, and tracking. Activities that support these functions are base operations, construction, and range support.

1.2 PURPOSE

The purpose of the Proposed Action is to conduct tests and collect data in support of:

- Continuing research, development, and operational missions

- Operational space track missions
- Strategic Defense Initiative (SDI) research, development, test, and evaluation (RDTE) activities

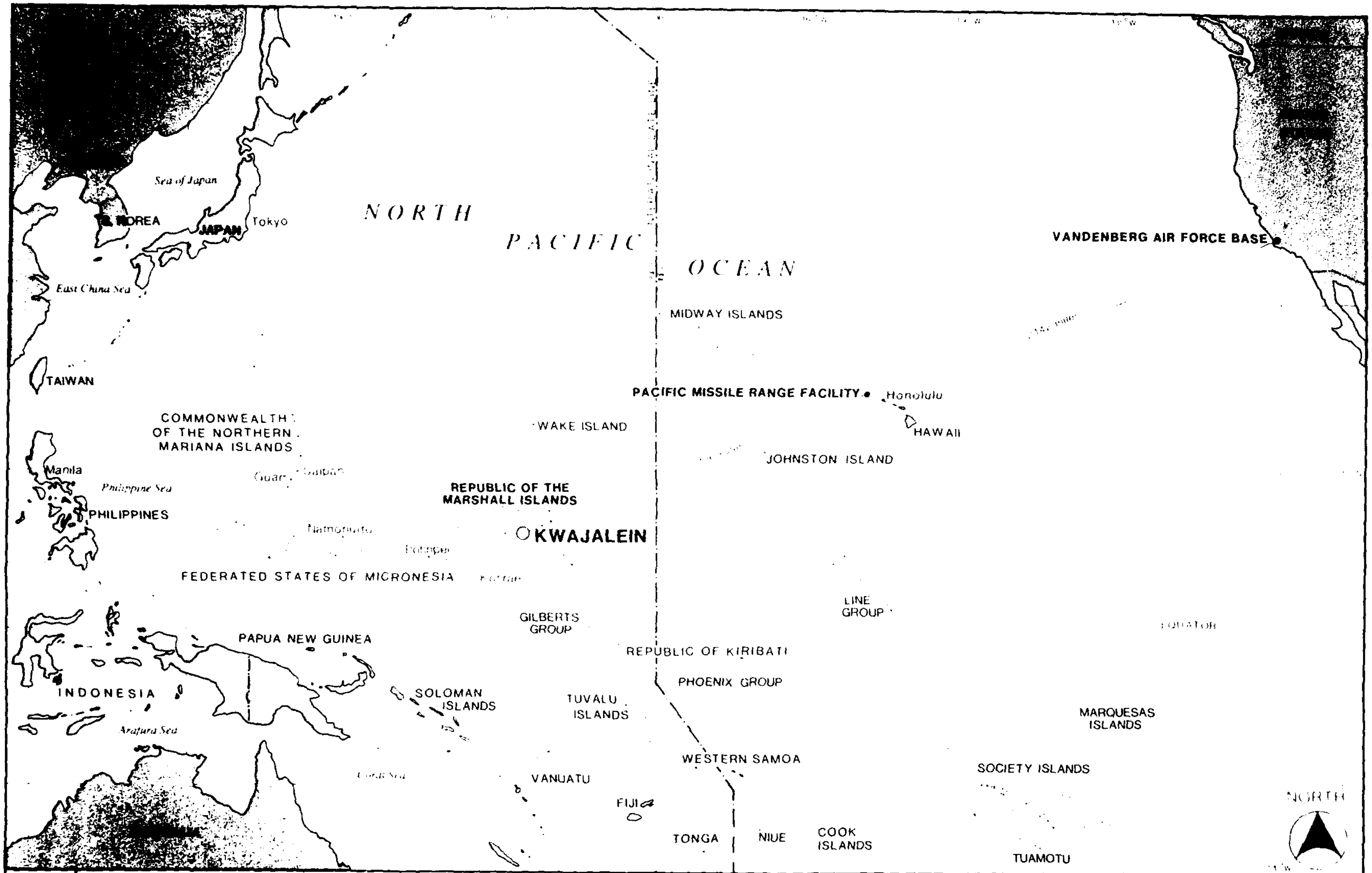
USAKA, as a national test range, has the capability and the capacity to support a variety of U.S. governmental programs. The purpose of the Proposed Action and alternatives is to continue the programs currently using USAKA and to include those programs planning to use USAKA through 1998. The current testing and data collection activities at USAKA are described in Chapter 2, Section 2.2, and the future planned testing and data collection activities are described in Section 2.3.

1.3 NEED

USAKA provides facilities and services to support the Proposed Action. USAKA is a national asset that supports programs vital to national security. The Department of Defense (DOD) and other federal agencies sponsor tests associated with these programs at USAKA to provide necessary information to make decisions concerning operational characteristics of ICBMs and SLBMs, current space activities, and RDTE activities associated with sensing and tracking of ballistic missiles. USAKA provides essential support for the United States' capabilities and growth in these technologies.

USAKA resources ensure that the United States' strategic forces will continue to provide the necessary deterrent effect that will prevent global conflict. USAKA's opportunistic look angle and distance from the United States allow observation of ballistic missile launches in support of two legs (ICBMs and SLBMs) of our strategic offensive triad (land, sea, and air). Additionally, the United States needs the ability to track objects in space both to support space programs and to assess the space activities of other nations. USAKA supports the United States' space surveillance mission through the use of sensing and tracking capabilities to monitor missile launch activities of foreign nations.

In 1983, President Reagan announced the Strategic Defense Initiative to investigate the feasibility of developing an effective defense system against ballistic missiles. The Strategic Defense Initiative Organization (SDIO) was established to plan, organize, coordinate, direct, and enhance the research and testing of the technologies applicable to strategic defense. SDI will provide flexibility in maintaining the balance between strategic offensive and defensive forces. The additional capabilities demonstrated

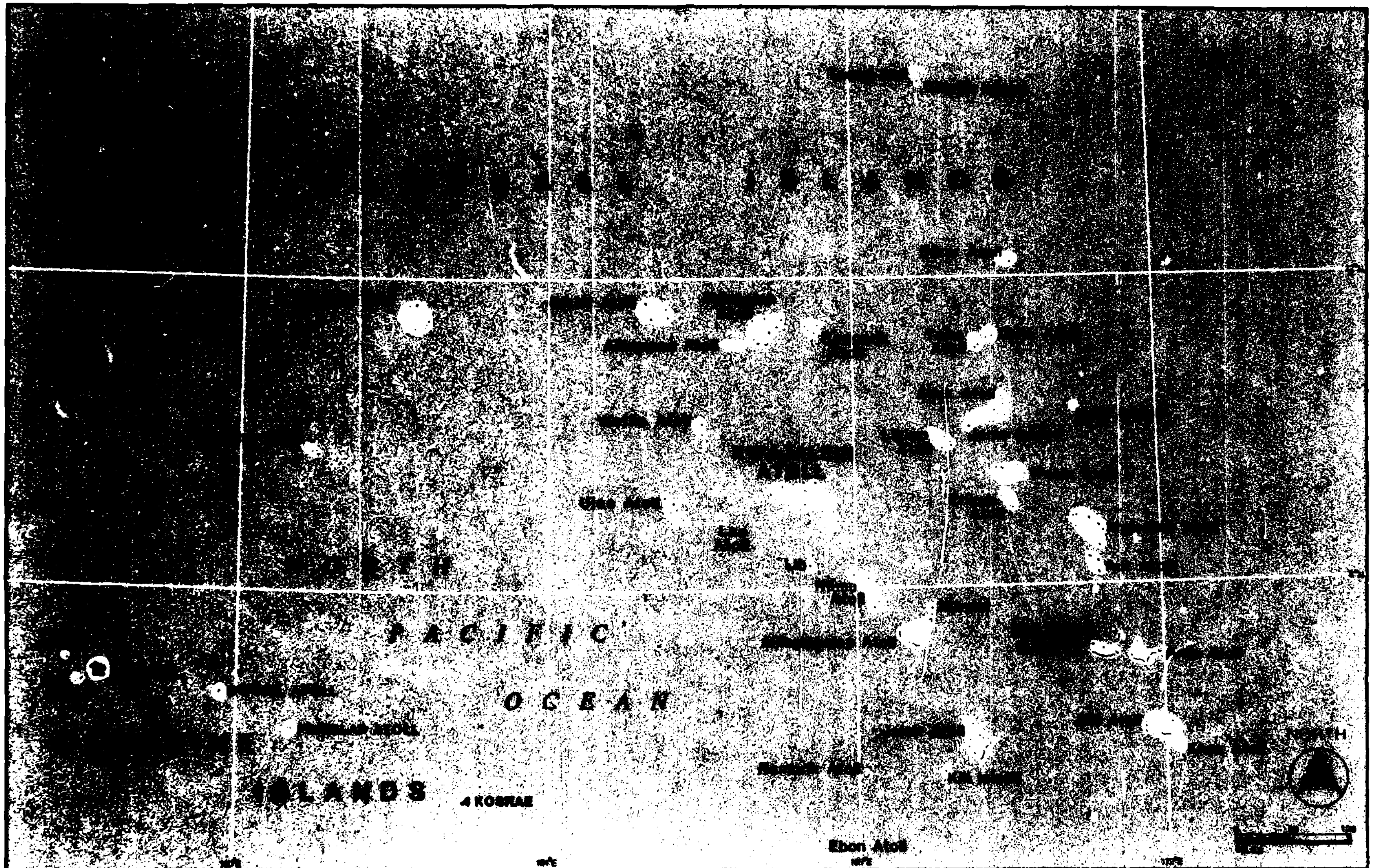


U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

MERCATOR PROJECTION

NORTH PACIFIC OCEAN

Figure 1.1-1



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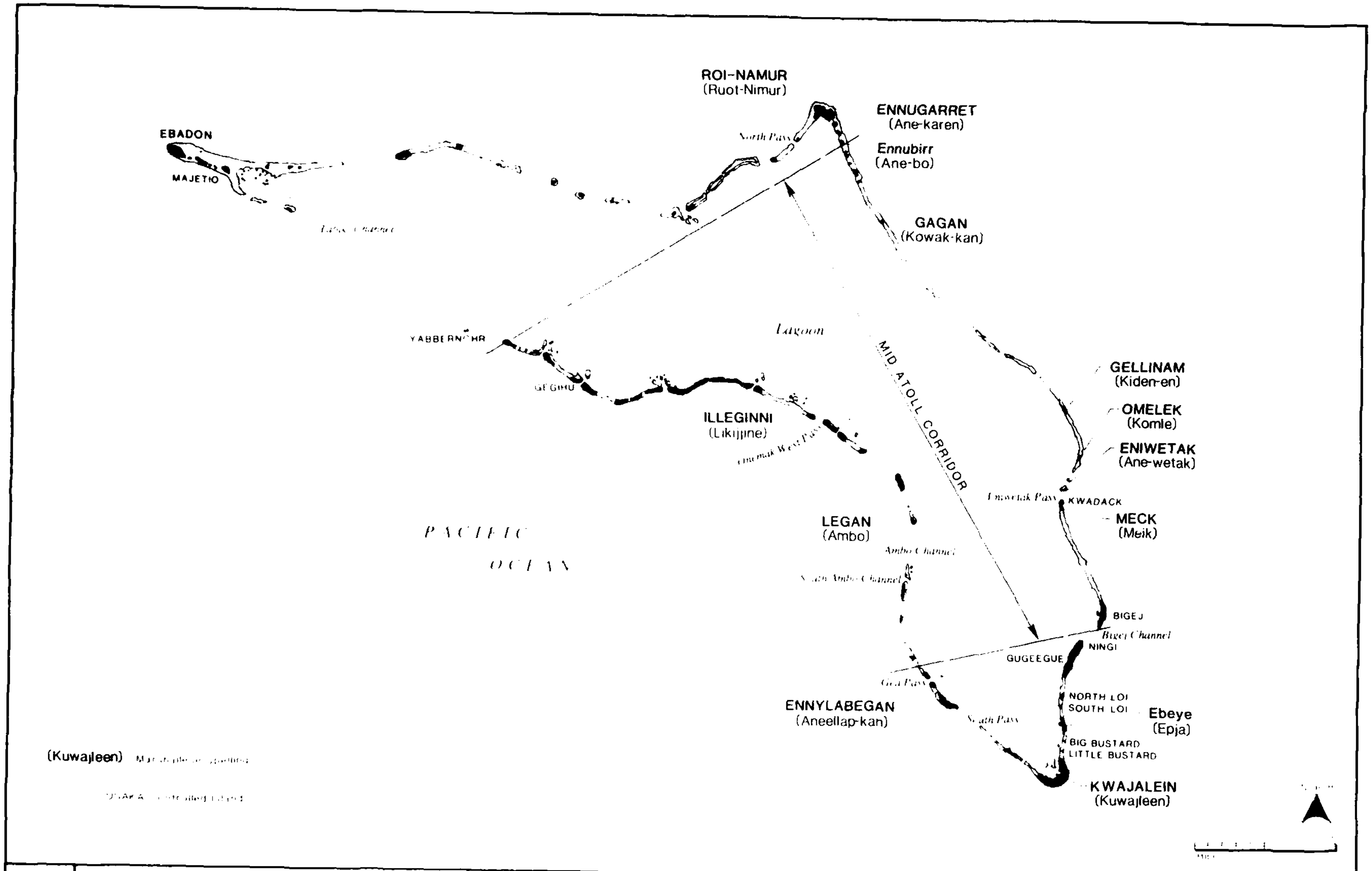
REPUBLIC OF THE MARSHALL ISLANDS

Figure 1.1-2



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KWAJALEIN ATOLL

Figure 1.1-3

through SDI will enhance the nation's capacity to deter enemy launches of ballistic missiles.

USAKA is one of two national test ranges recognized in the 1972 Anti-Ballistic Missile (ABM) Treaty between the Soviet Union and the United States for conducting land-based testing of ABM radars, launchers, and missiles. There are safety considerations and range size limitations at the White Sands Missile Range (the other range recognized in the treaty); therefore, USAKA provides an opportunity for more realism and flexibility in the ABM test program. This makes USAKA an important asset in the support of ABM testing. Without this capability, the United States would be hampered in its ability to test and evaluate ABM technologies.

1.4 SCOPE OF THIS DEIS

This document is prepared in compliance with the National Environmental Policy Act (NEPA), its implementing regulations, Department of Defense (DOD) Directive 6050.1, and Army Regulation (AR) 200-2, Environmental Effects of Army Actions. The relationship between the United States and the Republic of the Marshall Islands is currently governed by the Compact of Free Association Act of 1985, Public Law 99-239 dated January 14, 1985.

This draft environmental impact statement (DEIS) analyzes the environmental consequences of continuing and proposed operations, research, and testing activities at USAKA. The scope of this DEIS includes the assessment of impacts from continuing operations at their present level, which represents the No-Action Alternative. This analysis provides the baseline description of environmental conditions at USAKA so that an analysis of future activities such as SDI tests can be made in comparison to the existing baseline. Future programs will be either separately assessed or this DEIS will be supplemented if they are not within the scope of this document. For SDI programs, this DEIS is part of an assessment process that was begun to support the decision to move the planned Phase I Strategic Defense System (SDS) technologies from concept exploration to demonstration and validation (Dem/Val) testing.

In 1987, SDIO prepared six environmental assessments (EAs) and a summary EA to support the Dem/Val decision. Three of the six EAs (Exoatmospheric Reentry Vehicle Interceptor [ERIS], Space-Based Interceptor [SBI], and Ground-Based Surveillance and Tracking System [GSTS]) concluded that there was a potential for cumulative impacts from SDI activities at USAKA as a result of increased population on Kwajalein Atoll and effects on socioeconomic conditions of the Marshallese people. As a result, the decision was made that

SDIO test activities at USAKA would be assessed in an EIS. At the conclusion of the EIS process, a decision will be made whether to go forward with SDI technology development and Dem/Val activities at USAKA. Further advancement of the Phase I SDS technologies in the acquisition process will be supported by additional environmental documentation in compliance with NEPA.

1.5 PUBLIC CONCERNS

Scoping meetings were held at:

- Majuro Courthouse, Majuro, RMI 24 March 1988
- Ebeye Island, Kwajalein Atoll, RMI 24 March 1988
- Central Intermediate School, Honolulu, Hawaii, U.S.A. 28 March 1988

Each scoping meeting was chaired by COL Richard Chapman, Commander of USAKA. Prior to each meeting, a list of U.S. Army-prepared Questions and Answers and a brief history of USAKA was provided to attendees. COL Chapman then presented a Command/Mission Briefing, which was similar for each audience.

The concerns raised at the scoping meetings or in subsequent written comments focused on the following items:

- Effects on the physical environment
- Request for additional information on USAKA activities
- Opportunities for jobs, social, and educational services
- Concerns about health and safety
- RMI and USAKA interactions

The relevant issues and concerns listed above are addressed in this DEIS.

Chapter 2
ALTERNATIVES CONSIDERED

2.1 INTRODUCTION

Three alternatives are considered in this DEIS: the No-Action Alternative, the Proposed Action, and a Change of Duration Alternative. Additionally, two alternatives are discussed briefly in Section 2.6 (reduced activities at USAKA and the relocation of the missile range and SDI activities); these were eliminated as unreasonable. This chapter includes a description of the alternatives, a comparative presentation of impacts, and a summary of mitigation measures.

The following paragraphs and Table 2.1-1 summarize the alternatives considered:

- No-Action Alternative. This alternative is the continuation of current mission activities and their associated technical and logistical support at USAKA.

- Proposed Action. This alternative combines all the activities included in the No-Action Alternative with new SDI testing and associated construction. In addition, five major construction projects in support of base operations are included as related actions.

- Change of Duration Alternative. This alternative schedules some elements of SDI testing over a more extended period. It was examined to determine whether the environmental consequences of the Proposed Action could be reduced by extending the schedule over a longer period.

Table 2.1-1
SUMMARY OF ALTERNATIVES

Feature	No-Action Alternative	Proposed Action	Change of Duration Alternative
Launches	HAVE-JEEP VII Sounding Rockets Meteorological Rockets	No-Action Alternative, plus ERIS, HEDI, SBI, and GSTS launches	Same as Proposed Action except HEDI operations delayed 4 years
Reentry Vehicles	MMI-III, Peacekeeper, ERPA, MAST, Trident, Small ICBM tests	Same as No-Action Alternative, plus reentry vehicles for ARE, AOA, EDX, GBR-X, HALO/IRIS, MCSE, OAMP, Project Cardinal, STARS	Same as Proposed Action except GBR-X operations delayed 2 years
Other Sensing/ Tracking Missions	Space surveillance Orbital Debris Radar Test	Same activities as No-Action Alternative	Same as Proposed Action
Range Support	Missile transportation, storage, assembly; range safety; KREMS complex; other radars; optical sensing; telemetry; Hyrdo-Acoustic Impact Timing System; communications, meteorological support, range safety; reentry vehicle search and recovery system; other technical range support	Same activities as No-Action Alternative	Same as Proposed Action
Base Operations	Air, water, ground transportation; electricity; water; sewer and sanitary facilities; solid waste; fire protection; security services; housing; community support; supplies and storage; maintenance and repair	Same activities as No-Action Alternative	Same as Proposed Action
Construction	No major construction	Construction for SDI launches on Meck and Omelek; GBR-X construction on Kwajalein; Liquid Nitrogen Plant for AOA. Other minor SDI-related construction/rehabilitation. Desalination plant, Kwajalein. Sewage treatment plant, Roi-Namur. Document Control Facility, Roi-Namur. Housing Construction, Kwajalein.	Same as Proposed Action
Population	December 1988 nonindigenous USAKA population: 2,972; no significant change predicted. Over the last 20 years, USAKA's nonindigenous population has ranged from 4,756 in 1971 to 2,577 in 1985.	Nonindigenous population increase related to SDI: 1989 77 1990 121 1991 142 1992 403 1993 403 1994 315 1995 20 1996 20 1997 0 1998 0	Nonindigenous population increase related to SDI: 1989 77 1990 121 1991 126 1992 124 1993 123 1994 137 1995 119 1996 201 1997 201 1998 181

PD432.019.1

2.2 NO-ACTION ALTERNATIVE

The No-Action Alternative consists of the continuation of ongoing (non-SDI) test programs and the technical and logistical facilities and activities that support them (see Figure 2.2-1).

For 30 years, Kwajalein Atoll has been used for DOD anti-ballistic missile systems testing, missile reentry studies, and (more recently) space surveillance. The level of activity at USAKA has varied considerably over that period. During the early and mid-1950s, for example, Kwajalein Island was the site of substantial amounts of construction and operations to support the Korean conflict and nuclear testing at Bikini and Eniwetak Atolls. By the late 1950s, however, those operations had ended and in 1959 the Navy placed Kwajalein on the military base surplus list with the intent of abandoning it. Later that year, Kwajalein was selected as the testing site for the NIKE-ZEUS Anti-Missile Program and a new period of activity began.

Most of the current USAKA testing activities involve the sensing and tracking of incoming reentry vehicles (RVs) and space objects such as satellites and foreign missile launches. In the past, USAKA was the launch location for a number of missile development efforts, including NIKE-ZEUS, NIKE-X, and Sentinel/Safeguard.

More recently, from 1982 to 1984, Meck Island was the site of missile launches to support HOE. The HOE program tested a technology for optically homing non-nuclear interceptor missiles capable of destroying exoatmospheric reentry vehicles. In 1984, an HOE interceptor launched from Meck Island successfully destroyed an incoming dummy warhead launched from Vandenberg Air Force Base (AFB). The HOE program was a particularly active period at USAKA; during the peak of HOE activities, the nonindigenous population exceeded 3,500 people.

In early 1989, 12 programs were active at USAKA or were scheduled to begin testing during the 1989 to 1992 period (see Figure 2.2-2). The number of active programs at USAKA varies considerably from year to year, but this number is indicative of the level of activity in recent years.

Missile launches at USAKA are currently limited to rockets launched from Roi-Namur for the HAVE-JEEP program, meteorological rockets launched from Kwajalein and Omelek, and sounding rockets launched from Omelek.

The testing programs at USAKA are directly assisted by a complex set of range support activities including communications, meteorological support, safety programs, RV search

and recovery, and data processing. In addition, a wide range of base support activities provide the logistical underpinnings for the testing programs and range support activities. Base support activities include transportation, utilities, housing and community support, and maintenance and repair.

The following subsections describe the ongoing test activities at USAKA and the range and base activities that support the test programs.

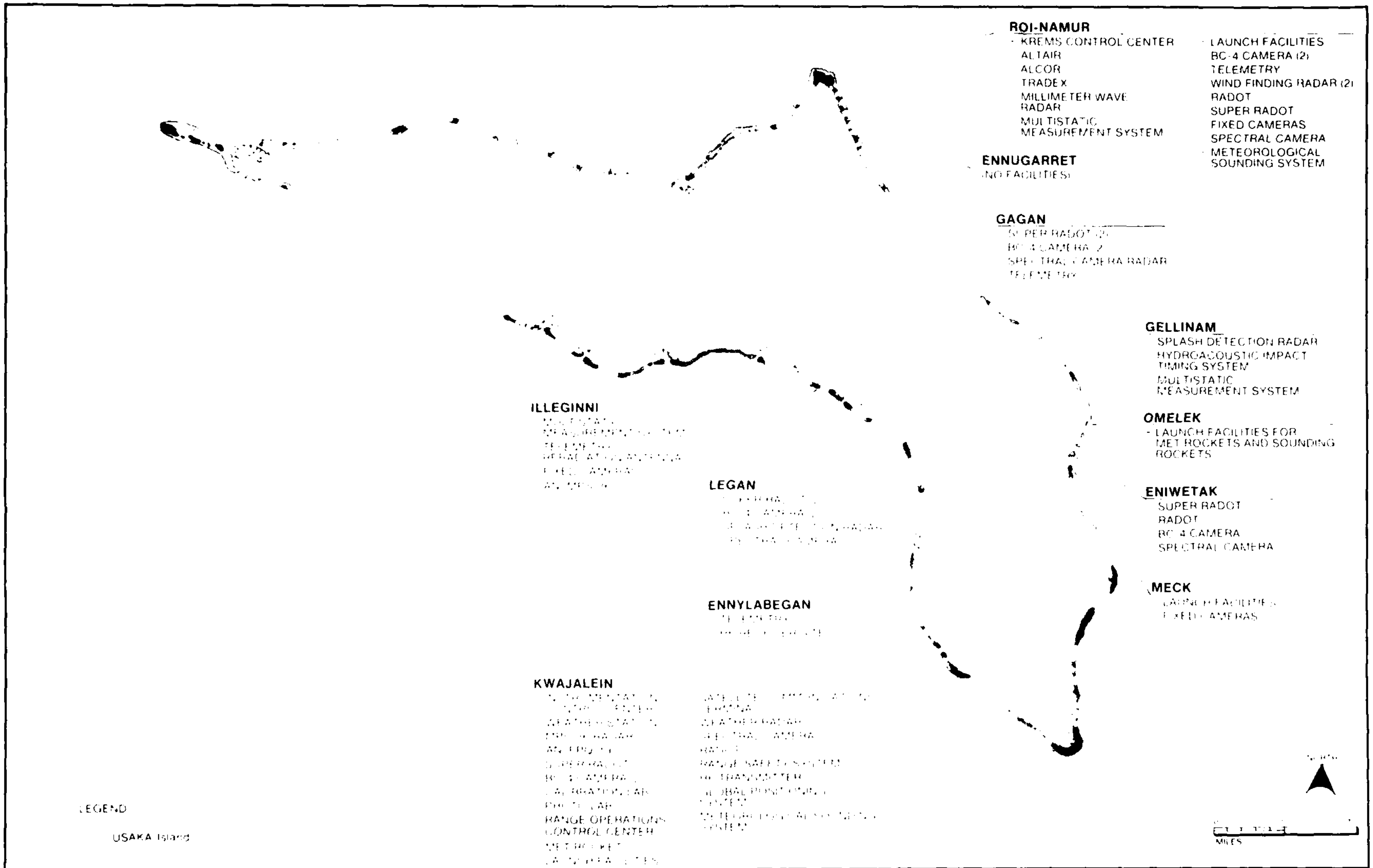
2.2.1 MISSILE LAUNCHES

Ongoing operations at USAKA include routine missile launches for determining meteorological conditions, for calibrating and testing radar and other ground-based sensing instrumentation, and for performing experimental payload tests (see Figure 2.2-3). The most frequently used missiles are PWN11 and PWN12A meteorological (met) rockets, which are launched from facilities located on Kwajalein and Omelek Islands for the purpose of determining wind speed and other atmospheric weather conditions experienced by scheduled test missions. The missions may include launches from USAKA or incoming RVs. Met rockets are launched up to 25 times per year.

A sounding rocket, the APACHE, is launched from Omelek Island prior to scheduled missions for the purpose of testing and calibrating radar and optical sensing instrumentation. These launches precede launches of experimental payloads from USAKA and tracking missions for incoming RVs.

Launches are scheduled for ongoing test flight programs at USAKA. A current program, HAVE-JEEP VII, is used for the collection of exoatmospheric long wave infrared (LWIR) data. This series of launches has five missions scheduled during the period 1987 to 1991. The missile used in the HAVE-JEEP VII program consists of a three-stage booster system and payload. The present HAVE-JEEP series uses a first-stage TALOS motor, a second-stage SERGEANT motor, and a third-stage HYDAC motor. The HAVE-JEEP rockets are launched from Roi-Namur toward the broad ocean area (BOA) north (85 nautical miles north of Roi-Namur).

The transportation, assembly, and launch of missiles are performed in accordance with USAKA range safety procedures described in Section 3.14, Range Safety.



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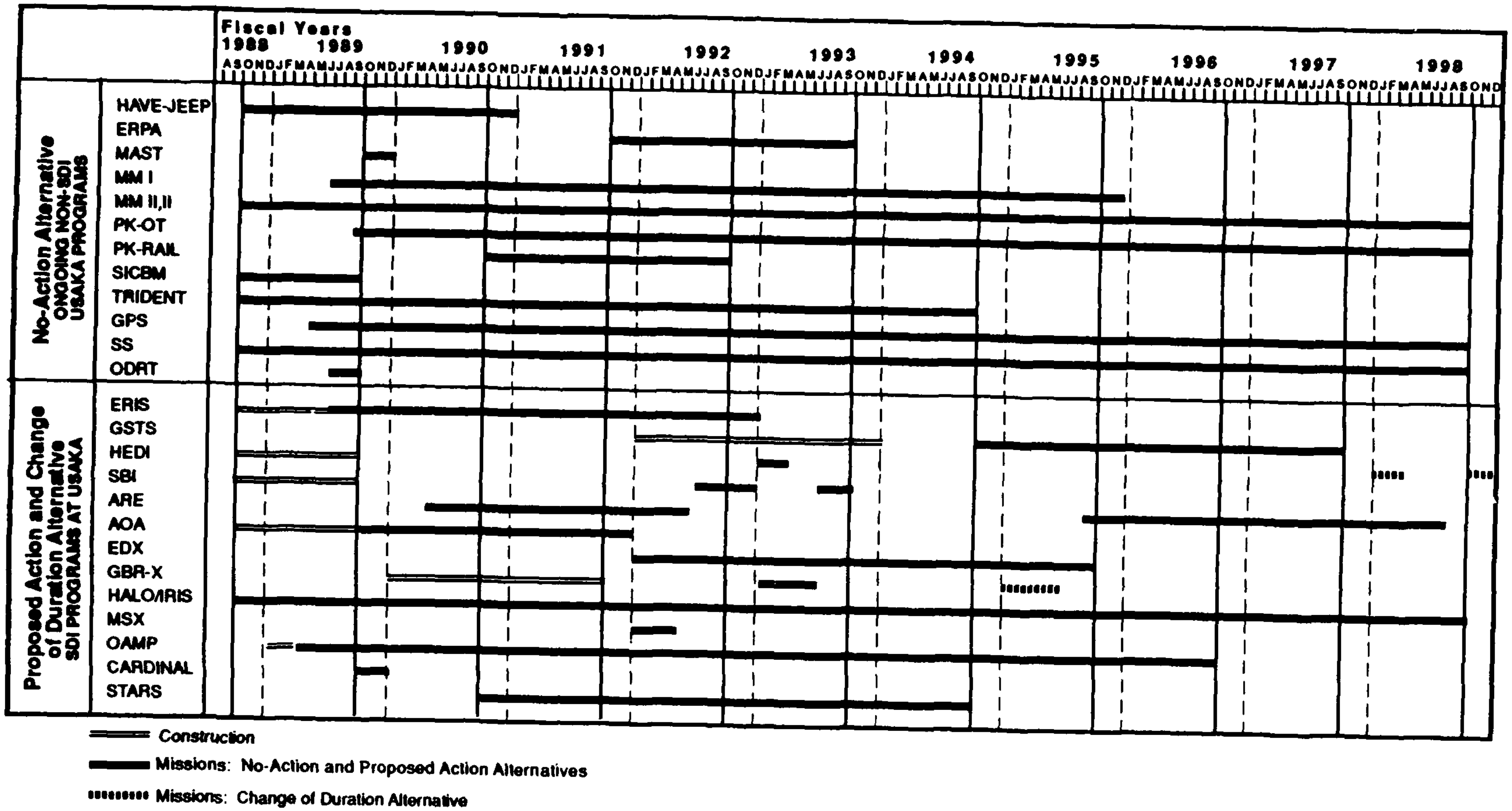
USAKA RANGE SUPPORT FACILITIES

Figure 2.2-1



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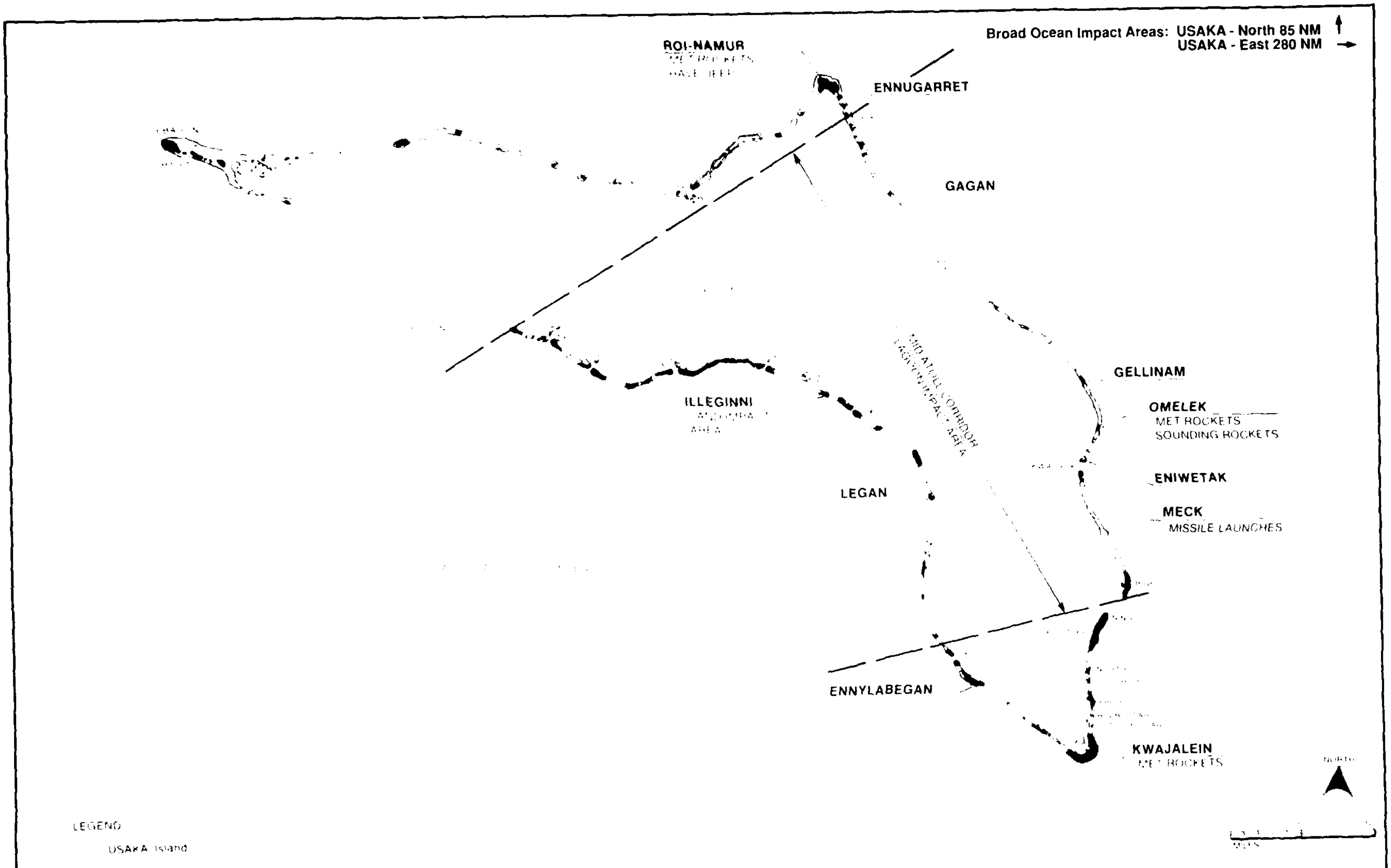
SCHEDULE OF MISSIONS AT USAKA

- NO-ACTION ALTERNATIVE
- PROPOSED ACTION
- CHANGE OF DURATION ALTERNATIVE

Figure 2.2-2



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LOCATION OF LAUNCH FACILITIES AND RE-ENTRY VEHICLE IMPACT AREAS

Figure 2.2-3

2.2.2 SENSING AND TRACKING

The sensing equipment at USAKA is used for missions involving RVs (Figure 2.2-4) and for tracking space objects.

Sensing and tracking functions at USAKA are carried out by radar, optical, and telemetric instruments located on 10 of the 11 USAKA islands (all but Ennugarret), and by hydroacoustical instruments located in the lagoon and ocean.

The Kiernan Reentry Measurements Site (KREMS), located on Roi-Namur Island, consists of five radars that can be operated independently or in conjunction with each other to track RVs and space objects. The KREMS radars include the ALTAIR, ALCOR, TRADEX, Multistatic Measurement System (MMS), and Millimeter Wave Radar (MMW).

The KREMS radars emit electromagnetic radiation (EMR) in several frequencies. The exposure of workers and residents of Roi-Namur to hazardous levels of EMR is prevented by a combination of building height restrictions and physical and software restraints on the radar equipment, which prevent the radars from "looking" in directions that would impose hazards to people (see Chapter 3, Section 3.15, for more details). The TRADEX radar, for example, is normally controlled by a mechanical lock that prevents the radar from looking below 2 degrees above the horizon. The 2-degree lock imposes a 36-foot building height restriction on the island. During certain operations, the TRADEX radar must look below the 2-degree limit. In that circumstance, personnel must be evacuated from the Namur side of the island, except for those who work within shielded buildings.

The Lincoln Laboratory of the Massachusetts Institute of Technology provides the scientific direction for the KREMS complex; General Electric and General Telephone and Electric are under contract to operate the radar facilities. The KREMS facilities are operated from the KREMS Control Center by personnel who live in bachelor quarters on Roi-Namur or who commute to the island each day by aircraft.

Although the KREMS complex on Roi-Namur is the largest concentration of radar facilities in the atoll, a number of other radars supplement the KREMS system. Splash detection radars on Gellinam and Legan are X-band radars that detect the splash of an RV as it hits the surface of the lagoon. Two AN/MPS-36 radars are general-purpose instrumentation tracking radars located on Kwajalein and Illeginni Islands. The AN/FPQ-19 radar system on Kwajalein is a high-accuracy, long-range radar. Two WF100-4/2 Wind Finding Radars located in the Launch Operations Control Building on Roi-Namur are

used with balloon-borne radar targets to gather data on winds aloft. These radars, like the KREMS radars on Roi-Namur, have operational restrictions and associated building height limitations to protect workers and residents from exposure to hazardous EMR emissions.

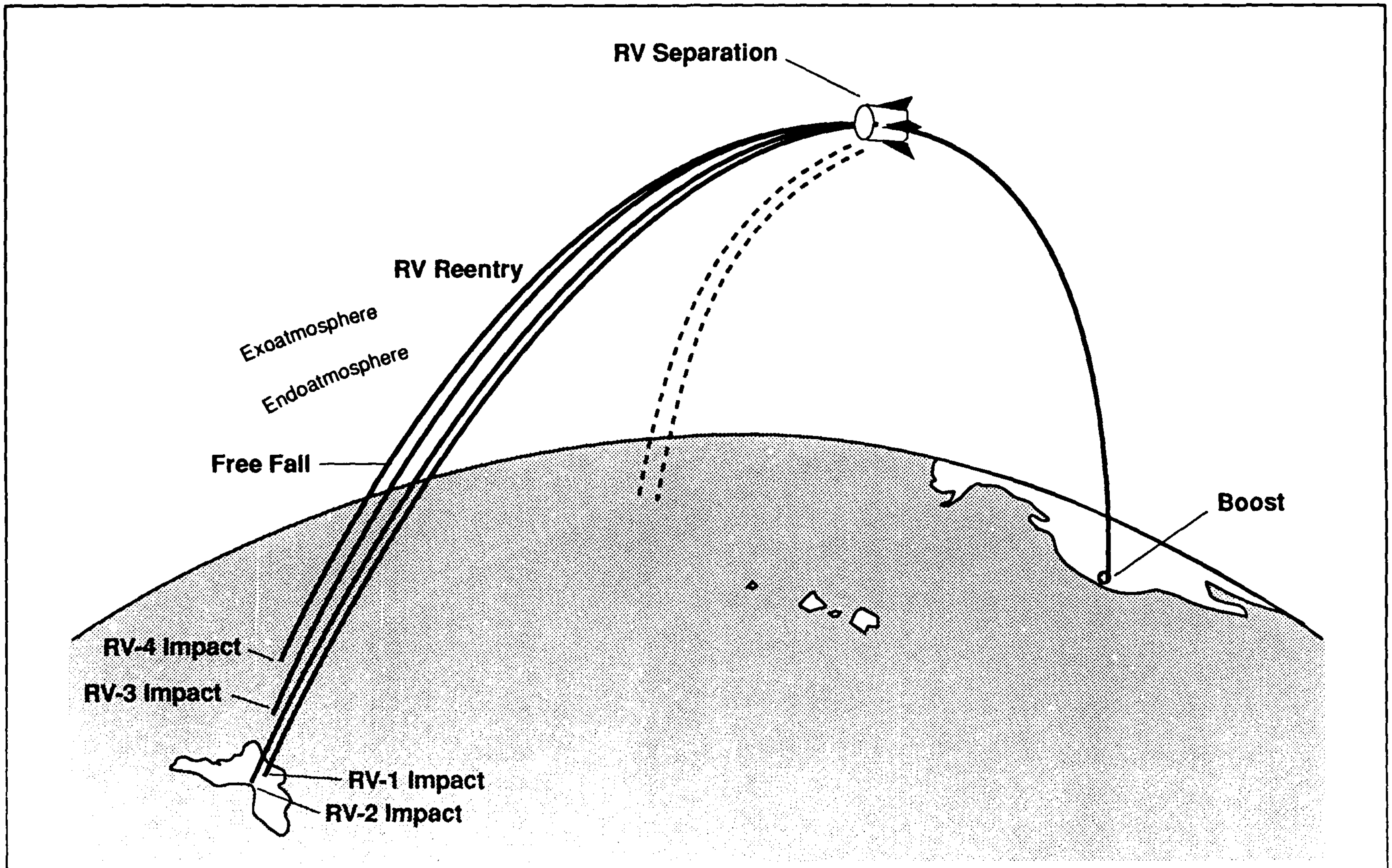
Optical equipment provides metric data (i.e., information on position versus time), signature data (i.e., information on the radiant intensity of missile exhausts and RV plumes), as well as still photos and films of reentry. Equipment includes tracking camera systems (Recording Automatic Digital Optical Trackers [RADOTS and Super RADOTS]), fixed camera systems, spectral ballistic plate cameras, fixed camera towers, and closed circuit television. Optical equipment is located on Kwajalein, Legan, Illeginni, Roi-Namur, Gagan, Omelek, Eniwetak, and Meck Islands.

Telemetry equipment receives data transmitted by RVs, missiles, and aircraft. Ten antennas with multiple recording capabilities are located on Roi-Namur, Ennylabegan, and Gagan Islands. Illeginni Island has a reradiation system to relay information to other points in the atoll.

The Hydro-Acoustic Impact Timing System (HITS) is an underwater sound detection system that detects and records the impact of RVs hitting the surface of the lagoon. It consists of four underwater hydrophones and three velocimeters linked by cable to a station located on Gellinam. RVs targeted for the BOA are located or "scored" using the Sonobuoy Missile Impact Location System (SMILS). This system consists of transponders set at precise locations on the ocean floor and a set of floating sonobuoys dropped into place by an airplane before missions. Through triangulation, technicians use data from the ocean transponders and the floating sonobuoys to locate precisely the impact of an RV in the ocean.

2.2.2.1 Sensing/Tracking Programs Involving Reentry Vehicles

The programs described below involve the launch of missiles that release one or more RVs targeted to the USAKA area. RVs are launched from the Pacific Missile Range Facility at Barking Sands Airfield, Kauai, Hawaii, and the Western Space and Missile Center (WSMC) at Vandenberg AFB, California. They are targeted to one of three general areas at USAKA: the mid-atoll corridor within the lagoon, the BOA (USAKA North, located approximately 85 nautical miles north of Roi-Namur, or USAKA East, located approximately 280 nautical miles to the east of Roi-Namur), or a land target area on the north side of Illeginni Island. Most RVs contain payloads made up of sensing equipment, test materials, or decoys. RV payloads typically contain no toxic or hazardous



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INCOMING REENTRY VEHICLE SCHEMATIC DIAGRAM

Figure 2.2-4

materials. In most cases, portions of the RVs burn up in the atmosphere on reentry; portions that survive reentry are either lost in the ocean or are recovered when targeted to the lagoon or the Illeginni land impact area.

USAKA supports these missions by providing tracking, sensing, RV recovery, and other technical and logistical support. The following test programs involving RVs at USAKA are either under way or are scheduled to begin during the 1989 to 1992 period (see Figure 2.2-3).

Evader Replica Penetration Aid (ERPA). The ERPA flight test program will gather radar, optical signature, and dynamic performance data on a new penetration aid system consisting of a replica decoy and an RV covered by a shroud designed to duplicate the signature of the replica. The Minuteman I, Minuteman III, or Peacekeeper missiles may be used for three missions scheduled for the period from 1992 to 1993. RVs will be targeted to the BOA.

Maneuvering Systems Technology (MAST). The MAST flight test program is a single-mission flight test (in late 1989) using a Minuteman I booster system launched from Vandenberg AFB and targeted to the lagoon. The test is designed to help evaluate nosetip and antenna window materials.

Minuteman I (MM I). MM I is a three-stage booster capable of delivering three RVs. It was formerly used in the strategic arsenal, but it has been replaced by later Minuteman missiles and other strategic missiles. Thirty-two booster sets are in storage and available for experimental test flights, of which fifteen are currently scheduled for use in Army missions at USAKA during the period from July 1989 through 1995. The missiles will be used to deliver experimental payloads into the lagoon or the BOA. A Short Time Interval Launch (STIL) is usually made once a year, during which two MM I missiles are launched within a short time.

Minuteman II (MM II) and Minuteman III (MM III) Operational Testing. Operational testing of MM II and MM III missiles is an ongoing activity at USAKA. Missiles are selected from the strategic arsenal, disassembled and transported to Vandenberg AFB and launched (with warheads removed). An average of two MM II launches and seven MM III launches are scheduled each year for the next 7 to 10 years. Objectives include testing of the booster and guidance systems and payloads of opportunity. The MM II missiles may have one RV, the MM III may have three RVs. RVs impact in the lagoon or, in the case of the MM III, are targeted for land impact on Illeginni Island several times each year. A STIL is usually made once a year.

Peacekeeper Operational Testing (PK-OT). PK-OT testing will involve the launching of Peacekeeper missiles from Vandenberg AFB into the lagoon, the BOA, or (for land impact tests) onto Illeginni Island. The Peacekeeper missile is a four-stage intercontinental ballistic missile capable of delivering as many as ten independently targeted warheads. Missiles will be launched with the warheads removed; on some launches, the warheads will be replaced with payloads for test missions. Approximately eight flights per year are scheduled to begin in 1990 and to continue for at least 10 years.

Peacekeeper Rail Garrison (PK-RAIL). Approximately four or five test launches from Vandenberg AFB are scheduled for 1991-92 to test train-based missile deployment. Missiles will be targeted for the lagoon, the BOA, or Illeginni Island. The Army may use these flights to test payloads.

Small Intercontinental Ballistic Missile (SICBM). Two test flights of the SICBM, each containing a single RV, are planned for 1989. RVs are targeted to the BOA.

Trident. Trident operational testing evaluates the strategic readiness of submarine-launched U.S. Navy TRIDENT missiles. Incoming RVs are targeted to the BOA. Testing is an ongoing activity that will continue at least through 1994. One or more launches per year are planned.

Global Positioning System (GPS). The GPS is being developed by the Air Force to provide military and commercial users with more accurate positioning information than can be attained with the existing system. The GPS uses a "constellation" of satellites, launched from Patrick AFB, Cape Canaveral. The Army will use the GPS system at USAKA to provide signals from which precise global position data--and thus more precise tracking--can be derived by sensors or missiles equipped to receive and process the signals. The GPS system will support a number of test programs, including SDI test programs. Installation and testing of the GPS system is occurring during the period March to December 1989.

In a test program of the GPS system at USAKA, new electronic equipment was installed at the existing telemetry building at Ennylabegan Island. During the test program, the Army will use three to seven temporary ground-based transmitters powered by portable generators at sites on Wake, Midway, or Johnston Islands; and Wotho, Likiep, Eniwetak, and Ailinglapalap in RMI. These temporary transmitters will be removed after each test.

2.2.2.2 Sensing/Tracking Programs Not Involving Reentry Vehicles

There are a number of sensing/tracking programs that do not involve RVs at USAKA. These programs monitor space objects and missile launches. The U.S. Space Command has a global mission to detect, identify, catalog, and track orbiting objects in space. The program supports virtually all U.S. space activities, including the NASA space shuttle and DOD missions. It provides much of its information on space objects to the United Nations. The catalog of space objects currently contains over 7,000 listings, from space labs to an astronaut's lost glove. USAKA is one of 27 links in the space surveillance network. The surveillance program began at USAKA in 1984 and is expected to continue indefinitely.

Specific functions performed in the space surveillance program include Space Object Identification (which catalogs all man-made space objects using the ALTAIR radar) and Space Object Measurement (which uses radars and optical sensors to identify near-space objects). USAKA also tracks the Space Transportation System (STS)(the space shuttle) using a combination of the TRADEX, ALCOR, and AN/FPQ-19 radars to assist NASA.

Space surveillance activities also include occasional specific projects, such as the Orbital Debris Radar Test (ODRT), for which NASA uses the ALCOR radar to track space debris.

2.2.3 RANGE SUPPORT

The launch and sensing/tracking capabilities of USAKA are supported by the following technical functions.

2.2.3.1 Communications

Intra-atoll communications facilities include:

- A Digital Microwave System that connects ten of the islands (consisting of digital microwave radio stations on towers and control equipment)
- A bulk encryption system (to encode communications)
- An inter-island telephone system
- Closed-circuit television (on Kwajalein, Omelek, and Roi-Namur)

Long-distance communications facilities include satellite and high-frequency radio communications with Hawaii and the U.S. mainland, as well as facsimile and other data transfer services.

2.2.3.2 Meteorological Support

Meteorological data collection includes:

- Surface (conventional) observations
- Upper air soundings using rawinsondes (a small radio transmitter tracked via radar to provide information on winds aloft), meteorological rockets, theodolites (surveying instruments used to determine heights), and wind-finding radars
- Data gathered from meteorological satellites and radar observations

Meteorological facilities are located on Kwajalein, Roi-Namur, and Omelek.

2.2.3.3 Range Safety

The Range Safety System is a set of autonomous systems that include a Range Safety Center (located on Kwajalein), dedicated transmitters, antennas, graphics displays, and computers. The safety system uses data supplied by radars throughout USAKA and has the capability to transmit a flight termination signal to airborne test vehicles. Chapter 3, Section 3.14, Range Safety, describes USAKA range safety procedures in detail.

As part of the USAKA range safety practices and pursuant to the Compact and related agreements, the Mid-Atoll Corridor (Figure 2.2-3) is maintained as a closed area. No permanent residences are permitted on the islands within the Corridor. All boat traffic is prohibited from the Corridor for a period encompassing each RV impact. At other times, boat traffic and fishing are allowed. During three 6-week periods each year, Marshallese are allowed to visit non-USAKA islands within the Corridor.

2.2.3.4 Reentry Vehicle Search and Recovery System

Reentry vehicles targeted to the lagoon are recovered for environmental and RV development reasons. Search and recovery operations are based on Kwajalein and include divers who use scuba equipment, a two-man submarine, and a remotely operated submersible.

RVs targeted to the BOA north or east of the atoll are scored with the SMILS, which includes sonobuoys and deep ocean transponders. Optical tracking is provided by airborne cameras and Ennylabegan provides telemetry support.

2.2.3.5 Other Support

Other support facilities located on Kwajalein include:

- The Range Operations Control Center
- A photographic laboratory
- A mobile frequency control and analysis unit
- A calibration laboratory
- A timing and range countdown system
- A variety of specialized computer facilities

2.2.4 BASE OPERATIONS

USAKA is both an Army base that employs highly sophisticated technical equipment and a community that has a population of 2,972 (December 1988). Base operations at USAKA include most of the municipal functions and community services found in towns of the same size in the U.S., plus additional activities specific to Kwajalein's isolation and tropical climate.

Ongoing base operations are managed in large part by USAKA's *prime logistics/engineering contractor,* which is currently Pan Am World Services. The following subsections summarize ongoing base operations. More detailed information on current operations and their environmental effects is provided in Chapter 3.

2.2.4.1 Transportation

Transportation services, summarized below, are discussed in more detail in Chapter 3, Section 3.11, Transportation.

Air Transportation. Air service within the atoll is provided by turboprop aircraft between Kwajalein and Roi-Namur. Long-distance air service is provided by commercial jet and by the Military Airlift Command. USAKA currently has airfields on Kwajalein and on Roi-Namur. Other islands are served by helicopter.

Marine Transportation. Ocean cargo service is provided to USAKA by barges and tugs; liquid fuel is brought by tankers. Local water transportation is provided by government-owned vessels, including harbor tugs; 1466-class landing craft, utility (LCUs); landing craft, materiel (LCMs); high-speed catamaran ferries; a 65-foot personnel boat; barges; and patrol boats.

Port facilities on Kwajalein include a hammerhead-type fuel pier, an L-shaped cargo pier, and a large bulkhead. Roi-Namur has a cargo pier and a cargo/fuel pier. The pier and a concrete marine ramp at Meck are currently being rehabilitated. The remaining USAKA islands have either a small pier and/or a marine ramp.

Land Transportation. Land transportation systems on Kwajalein and Roi-Namur consist of roadways and pathways for motor vehicles, bicycles, and pedestrians. Walking and bicycling are the primary means of transportation for most residents of these two islands. There is an average of about one bicycle per person on the islands. Bicycles are supplemented by shuttle buses and work buses, which transport people throughout Kwajalein and Roi-Namur free of charge. Motor vehicles are used almost exclusively for work and administrative functions.

2.2.4.2 Utilities

Electricity. USAKA maintains diesel fuel-powered generating plants and related electric utility facilities on ten islands in the Kwajalein Atoll (all except Ennugarret). Electrical distribution lines are all in underground duct banks. Outer island power plants have limited storage for the marine diesel fuel that is used for all engine generator sets. The fuel oil is barged to the outer islands from the main fuel storage facility on Kwajalein.

Water. Potable water on Kwajalein is provided through two sources: a rainwater catchment and a groundwater lens well system. The availability of water is of constant concern because of the variability of rainwater supply from the catchment and the relatively limited amount of fresh water available from the groundwater lens.

Kwajalein also has nonpotable (saltwater) systems used to flush toilets; to supply some of the fire hydrants, two saltwater swimming pools, and the boiler plant; and to provide cooling water for the diesel engines at the power plants.

Potable and nonpotable water systems both exist on Roi-Namur and Ennylabegan. The principal source of potable water is rainwater catchments. On Roi-Namur, rainwater catchment is supplemented by a groundwater lens well system. The nonpotable system on Roi-Namur is used for toilet flushing, power plant and KREMS radar cooling, and fire fighting. A potable water system and an abandoned nonpotable system are present on Meck. Water is transported to the other islands.

Sewer and Sanitary Facilities. On Kwajalein, wastewater receives secondary treatment before being discharged to the lagoon. On Roi-Namur, four septic tank/leach fields and one

outfall extending approximately 500 feet off the west end of Roi-Namur are used. Meck and Ennylabegan each have three septic tank/leach field systems. The other outer islands handle wastewater by collection in portable tanks that are disposed of on the island or transported to Kwajalein for treatment and discharge.

Solid Waste Management. Solid and hazardous waste are currently generated from base operations, primarily at Kwajalein and Roi-Namur Islands; these are the only 2 of the 11 USAKA islands that have established collection, transportation, and disposal facilities and operations. In Chapter 3, Subsections 3.12.3 and 3.12.4, waste management practices are described in detail.

2.2.4.3 Housing

USAKA's housing facilities include family housing, unaccompanied personnel housing (UPH), and transient/visitor (TDY) housing. All permanent USAKA housing is located on Kwajalein and Roi-Namur. Construction crews are housed in temporary camps on Kwajalein, Roi-Namur, and Meck. Workers on other islands commute to work by air or ferry. The housing inventory is presented in Chapter 3, Subsection 3.10.1.

2.2.4.4 Community Support

Recreation. A range of recreational facilities is essential for maintaining morale and health in an isolated installation such as Kwajalein. USAKA's recreational facilities (described in Chapter 3, Subsection 3.10.3) include facilities for both indoor and outdoor athletics, hobbies, and entertainment.

Education. USAKA's education facilities include preschool, elementary school, and a junior/senior high school located on Kwajalein.

Health Care. Hospital and medical facilities on Kwajalein include inpatient and outpatient care for medical, dental, and veterinary services. Medical services for Roi-Namur and Meck personnel are provided by clinics located on each island.

Religious Facilities. Chapels are located on Kwajalein and Roi-Namur.

Retail Sales Facilities. Retail facilities on Kwajalein Island include:

- "Macy's" (general retail store)
- "Macy's" West (specializing in gardening supplies, hardware, and sporting goods)

- Surfway (supermarket)
- Ten/Ten (convenience items and liquor)
- Tape Escape (videotape rental library)
- Bakery
- Laundromat
- Sands Barber Shop
- Bank of Guam
- Television Repair Shop
- Stars and Stripes Bookstore
- Bargain Bazaar (thrift shop)

Retail facilities in Roi-Namur include:

- "Gimbel's" (general retail store)
- Videotape rental library
- Bank branch

Food Service and Clubs. USAKA's permanent food service and clubs include:

- Two open messes (the Pacific Dining Hall and the Roi-Namur Mess)
- One main and two auxiliary snack bars
- Mobile canteen
- The Yokwe Yuk Club

Construction crews on Meck are served by a temporary dining facility on that island.

Information Services. The Hourglass is USAKA's newspaper. Libraries exist on Kwajalein and Roi-Namur, and the Armed Forces Radio and Television Service provides radio and television programming.

2.2.4.5 Fire Protection

Prevention and response measures to protect against fire exist on Kwajalein and the outer islands. Facilities include fire stations on Kwajalein and Roi-Namur. Fire prevention and response facilities on Meck are being upgraded in conjunction with construction on that island. Most buildings have fire suppression equipment, most of

which have been retrofitted with Halon fire suppression equipment. The fuel storage facilities are equipped with a foam fire suppression unit.

2.2.4.6 Security Services

Security and law enforcement at USAKA are provided by contractor personnel under a Security and Law Enforcement Contract (SLEC). The SLEC's performance is monitored and evaluated by the USAKA Commander and members of the Provost Marshal's Office. Security guards (SLEC personnel) are stationed on all USAKA islands except Ennugarret. On the outer islands, two guards typically share a 24-hour shift and are relieved each morning with a new crew flown in by helicopter.

2.2.4.7 Supplies and Storage

Ample storage is necessary for USAKA because of its distance from suppliers. Storage problems are compounded by the limited available land area, the 90- to 120-day period that typically elapses between order and delivery, the limited air and sea cargo services available to the island, and the island's severe climatic conditions.

USAKA's supply facilities fall into six categories:

- *Liquid fuel storage*
- Cold storage
- Dehumidified storage
- High-explosives storage
- General warehousing
- Salvage and surplus property

Most of USAKA's storage structures are located at Kwajalein and Roi-Namur, with smaller facilities on Meck and the remaining USAKA islands (except Ennugarret).

2.2.4.8 Maintenance and Repair

Quarrying. The reefs surrounding the USAKA islands have been the primary source of construction rock and aggregate for the installation. In the past, quarrying occurred on the reef flats of Kwajalein, Roi-Namur, Meck, Gagan, Gellinam, Omelek, and Legan Islands. Currently, active quarries exist on reef flats at Kwajalein and Roi-Namur.

Quarry rock is usually obtained from the material of the shallow reefs. Holes are drilled into the reefs and explosives are used in a carefully controlled way to loosen the rock. Material is lifted out by a backhoe positioned on a causeway that is built out to the quarry area. The material is loaded into trucks and hauled to two stockpile areas on

Kwajalein and one on Roi-Namur. Chapter 3, Section 3.2, Land and Reef Areas, describes quarrying operations in more detail.

Shoreline Protection. The islands of USAKA are very flat, with an average elevation of 6 feet above mean sea level. Because of their low elevation and erodible composition, the islands are dynamic and change size and shape over the years as a result of storms.

Over the years, shorelines of most of the USAKA islands have been altered with rock revetments, seawalls, berms, and other shore protection devices of varying degrees of effectiveness. Generally, shore modifications have used armor rock quarried from surrounding reefs. In a few locations, scrap metal or concrete rubble have been used as riprap. Shoreline repair is a continual activity at USAKA. Individual projects are identified as problems arise and are completed as budgets permit. Recently completed and ongoing shore repair projects include work on Illeginni, Eniwetak, and Roi-Namur. Shore protections are described in Chapter 3, Section 3.2, Land and Reef Areas.

Dredge and Fill Operations. Harbor areas have been dredged at most USAKA islands. Work is performed on an as-needed basis as problems develop and funds are available. Dredged material is stockpiled on Kwajalein and Roi-Namur. The material is transported from stockpiles by truck and/or barge as needed for construction throughout the atoll. Fill is generally used in all construction projects to raise the building above the surrounding area to reduce the risk of flooding. At least a dozen non-SDI projects now under way involve fill. The ongoing fill activities do not involve filling water areas. Section 3.2, Land and Reef Areas, describes dredge activities in more detail.

Asphalt and Concrete Production. On Kwajalein, Roi-Namur, and Meck, concrete is produced from aggregate that is crushed, screened, and stockpiled on Kwajalein. Concrete is used for miscellaneous small repair projects as well as major construction. In February 1989, concrete production requirements on Kwajalein for ongoing activities totalled over 12,000 cubic yards. Uses included new family housing construction, taxiway repairs, a new aircraft hangar, and miscellaneous projects. On Roi-Namur, approximately 4,000 cubic yards of concrete were used for the construction of bachelors quarters in early 1989.

Asphalt is produced on Kwajalein. Recent and ongoing uses of asphalt include taxiway emergency runway repairs and miscellaneous road resurfacing work.

Other Maintenance and Repair. A broad range of other maintenance and repair activities is required to maintain smooth

operation of the technical and logistical facilities of USAKA. These activities include aircraft, automotive, bicycle, and boat repair and maintenance; building repair and renovation; welding and carpentry shops; and appliance repair facilities.

Although maintenance and repair is an ongoing activity, there is usually a backlog of maintenance and repair (BMAR) for which funding is not available in the current year and separate funding is sought. In early 1989, the BMAR was estimated to be $32 million.

2.2.5 EMPLOYMENT AND POPULATION

The ongoing activities at USAKA are supported by a workforce made up of both indigenous (Marshallese) and nonindigenous (primarily American) workers. In December 1988, the total nonindigenous workforce included 1,529 operational employees based on Kwajalein and Roi-Namur and 282 construction workers based on Kwajalein, Roi-Namur, and Meck. The operational workforce included 40 military personnel, 84 federal civil service personnel, and 1,405 civilian contractor employees. These numbers do not include spouses and other dependents, some of whom are hired on-island to fill both full- and part-time jobs. One thousand eighty dependents were located on Kwajalein. In addition to this "permanent" nonindigenous population, the transient worker population averaged 22 per day during the month of December 1988.

The nonindigenous population at USAKA fluctuates from year to year, varying with the level of testing and its supporting facility construction and maintenance activities. The December 1988 nonindigenous population total of 2,972 was considerably less than the total of 4,756 experienced in 1971, but was roughly comparable to the 1980 level of 2,953.

A Marshallese workforce of 1,007 people (in December 1988) supplemented the nonindigenous workforce. This Marshallese workforce included 729 operational personnel employed in base support functions, 62 domestics employed by individuals under personnel service contracts, 183 construction workers, and 33 Job Corps trainees. A small share of this total works on Roi-Namur and lives primarily on the non-USAKA island of Ennubirr. The majority of the Marshallese workforce lives on the non-USAKA island of Ebeye and commutes to Kwajalein each day by ferry.

2.3 PROPOSED ACTION

The Proposed Action combines testing of SDI technologies at USAKA and the ongoing programs and activities described above for the No-Action Alternative. In addition, the Proposed Action includes, as Related Actions, several proposed construction projects that support base operations (see Subsection 2.3.3).

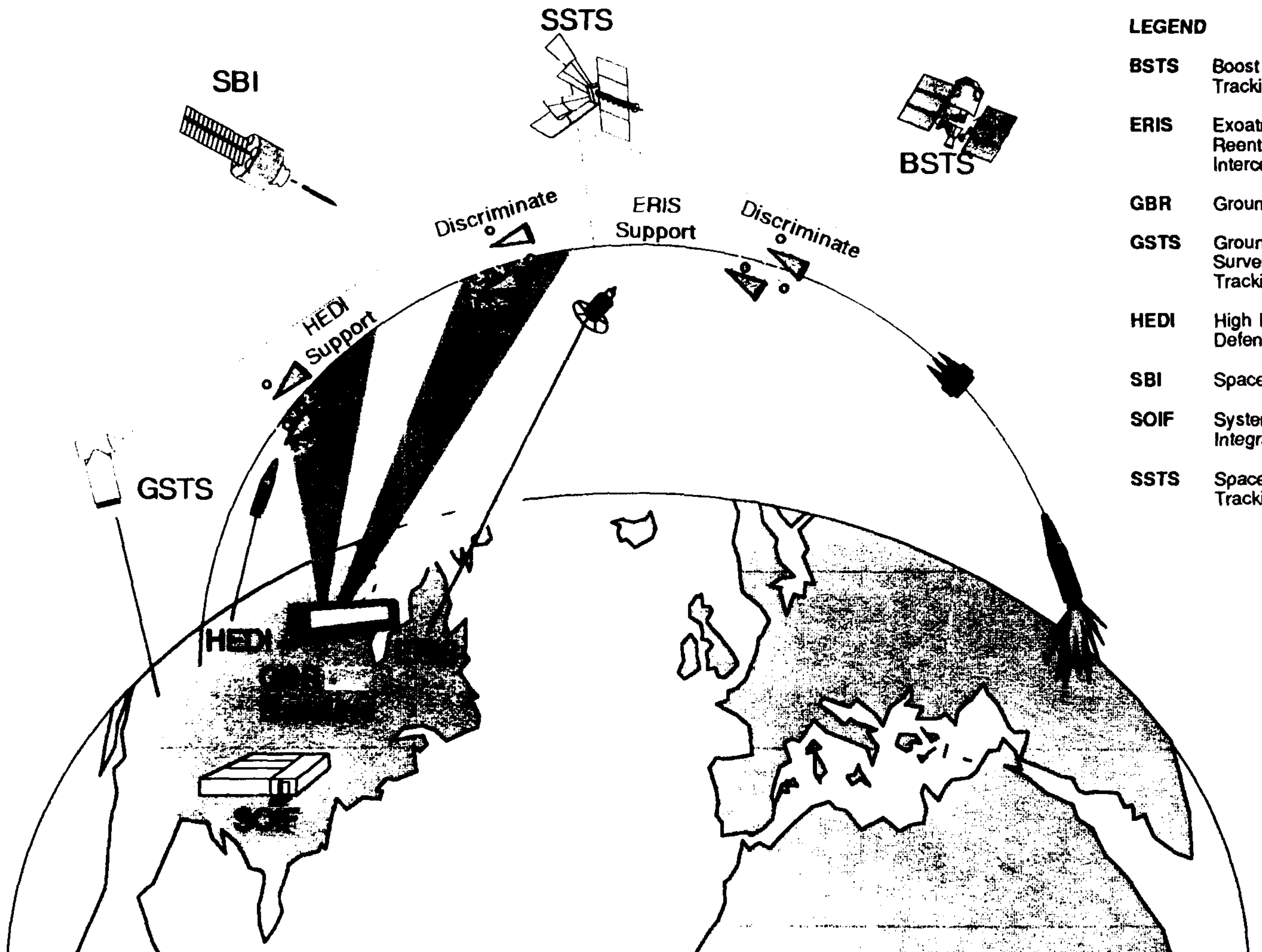
The SDI program is exploring the development of a non-nuclear defense system as depicted in Figure 2.3-1. The Concept Exploration phase has been completed for a number of SDI technologies. These technologies are now in the Dem/Val phase of the acquisition process. Dem/Val activities include analyses, simulations, component/assembly tests, and flight tests at more than 18 sites in the United States. Environmental Assessments have been prepared for the Dem/Val testing of six technologies, of which three are proposed for Dem/Val testing at USAKA--ERIS, GSTS, and SBI (sometimes called SABIR).

On July 31, 1987, SDIO issued a Finding of No Significant Impact (FONSI) for the analyses, simulations, and component/assembly testing of the six technologies, including the three listed above. However, the FONSI recognized that there is a potential for significant environmental impacts as a result of flight testing at USAKA and stated that an EIS would be prepared to address those actions and ongoing activities at USAKA.

This DEIS includes analysis of the USAKA testing activities of the technologies that were the subject of the 1987 EAs, and completes the environmental planning and documentation process for Dem/Val activities associated with testing of a planned Phase 1 Strategic Defense System. Further advancement of SDI in the acquisition process will be supported by additional environmental documentation in compliance with NEPA.

In addition to the three technologies proposed for Dem/Val testing at USAKA, a number of other testing activities associated with SDI are proposed to take place at USAKA. These include:

- Aerothermal Reentry Experiment (ARE)
- Airborne Optical Adjunct (AOA)
- Exoatmospheric Discrimination Experiment (EDX)
- Ground-Based Radar-Experimental (GBR-X)



LEGEND

BSTS	Boost Surveillance and Tracking System
ERIS	Exoatmoshperic ReentryVehicle Interception System
GBR	Ground-Based Radar
GSTS	Ground-Based Surveillance and Tracking System
HEDI	High Endoatmospheric Defense Interceptor
SBI	Space Based Interceptor
SOIF	System Operation Integration Function
SSTS	Space Surveillance Tracking System

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STRATEGIC DEFENSE INITIATIVE ARCHITECTURE

Figure 2.3-1

- High Altitude Learjet Observatory and Infrared Instrumentation System (HALO/IRIS)
- High Endoatmospheric Defense Interceptor (HEDI)
- Mid-Course Sensors Experiment (MSX)
- Optical Aircraft Measurement Program (OAMP)
- Project Cardinal
- Strategic Target System (STARS)

The Dem/Val and other SDI testing at USAKA would involve both missile launches and sensing/tracking activities. Some of the SDI programs at USAKA include the construction of new facilities or the rehabilitation of existing structures.

The components of each testing program are outlined below (Subsections 2.3.1 and 2.3.2). Figure 2.2-2 shows the proposed schedule of SDI testing at USAKA. Figures 2.3-2 through 2.3-5 show the locations of proposed construction.

2.3.1 LAUNCH PROGRAMS

The Proposed Action includes launch programs at USAKA: the ERIS, the HEDI, the SBI, and the GSTS. These launch programs are test flight programs for developing various SDI technologies. All of these programs require construction of new facilities or rehabilitation of existing facilities on Meck and Omelek Islands. In addition, the programs require new support facilities on Kwajalein Island for additional workforce, described below.

A number of the construction projects in support of SDI programs at USAKA were begun in late 1988 and are scheduled for completion by October 1989. Much of the construction has taken place on Meck Island, which was extensively altered and built up for the Spartan-Sprint programs in the mid-1960s and the HOE in the early 1980s. The launch facilities constructed for those programs, after rehabilitation/modification, would be used for the ERIS, HEDI, and SBI programs. Figure 2.3-4 shows the location of SDI-related construction on Meck.

A new quarry may be opened off the southeast corner of Meck Island to provide armor rock and aggregate. The new quarry would consist of two cells, one rectangular cell 300 feet by 250 feet and one triangular cell 150 feet by 650 feet by 675 feet (Figure 2.3-4) located in the ocean reef flat.

Meck Island construction is carried out by a contractor construction crew averaging 70 to 75 persons (Marshallese and American) on Meck Island. The construction crew is housed

in a set of mobile homes serviced by potable water and a septic tank/leach field. The construction camp is scheduled for demobilization after construction completion in late 1989.

2.3.1.1 Exoatmospheric Reentry-Vehicle Interceptor Subsystem (ERIS)

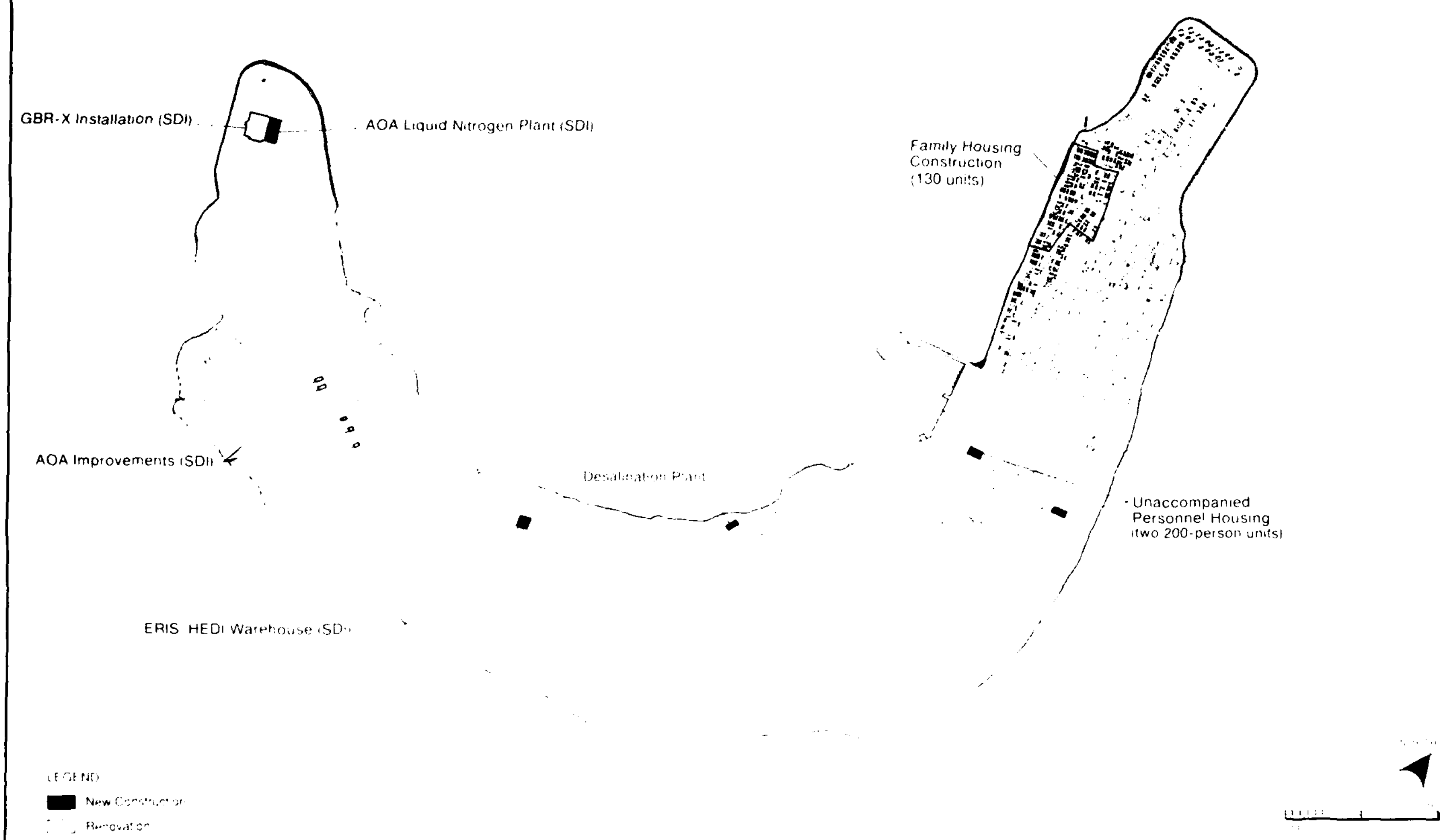
The ERIS interceptor consists of an ARIES II, two-stage booster, and a kill vehicle (KV) designed to intercept and destroy an incoming missile warhead using kinetic (non-explosive) energy. The KV has a divert (maneuvering) propulsion system containing monomethyl hydrazine (MMH) and nitrogen tetroxide.

The ERIS missile consists of an MM I second-stage booster as the first stage, an MM I third-stage booster as the second stage, and a KV with a divert propulsion system containing MMH and nitrogen tetroxide. The KV contains experimental instrumentation and a flight termination system.

The ERIS interceptor would be launched from a silo in a trajectory to the north and would intercept the target vehicle over the BOA. The spent booster cases, KVs, target vehicles, and debris from successful interception missions would fall into the BOA. Debris would not be recovered. The debris would contain no hazardous or toxic materials with the exception of small amounts of lithium in batteries, which would largely burn up on reentry.

The construction phase of the ERIS program includes the rehabilitation and modification of 24 existing structures, and the construction of five new buildings on Meck (some of these building would be shared with the HEDI and SBI programs as described below; see also Figure 2.3-4). The rehabilitated buildings include the Meck Island Control Building (Bldg. 5050), modified to contain technical support and launch control areas for ERIS, HEDI, and SBI; the Launch Equipment Room (Bldg. 5070); the ERIS Missile Assembly Building; the ERIS Payload Assembly Building (Bldg. 5087); the ERIS Launch Cell; and several warehouses, maintenance shops, and camera towers. Building 5090 would be rehabilitated to provide a nitrogen tetroxide storage area. The ERIS launch complex was the subject of a Record of Environmental Consideration issued 28 November 1986 by the Corps of Engineers, Honolulu Engineer District. An Environmental Assessment of the ERIS Dem/Val program was issued by SDIO in July 1987.

The program does not require construction at other USAKA islands. The radars, tracking, and other sensing and support facilities at other USAKA islands would be used during the ERIS missions.



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CONSTRUCTION AND RENOVATION
KWAJALEIN ISLAND

Figure 2.3-2

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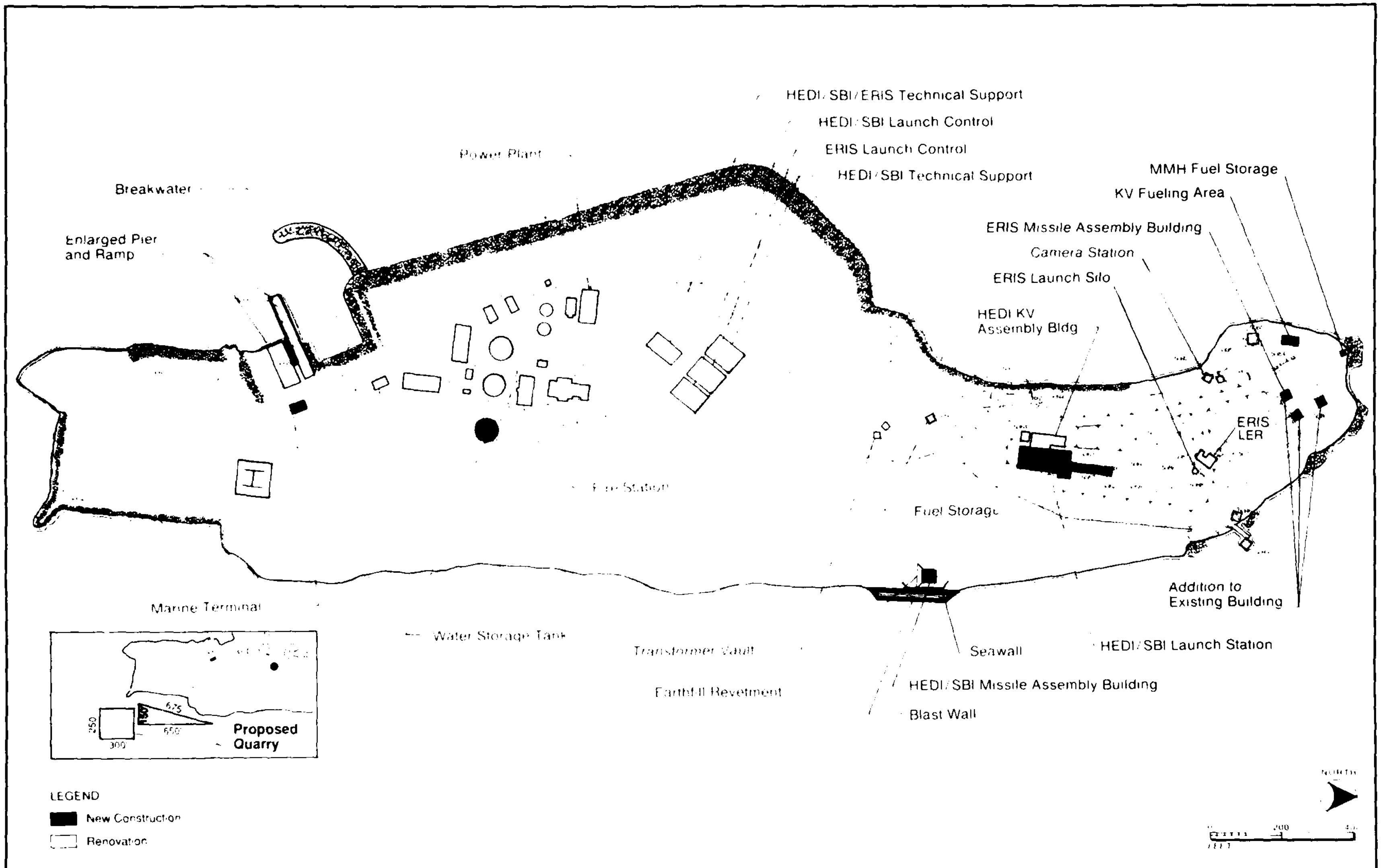
CONSTRUCTION
ROI-NAMUR ISLAND

Figure 2.3-3



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SDI CONSTRUCTION AND RENOVATION
MECK ISLAND

Figure 2.3-4

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SDI CONSTRUCTION
OMELEK ISLAND

Figure 2.3-5

The program is scheduled to be in construction from July 1988 through 1989. The peak of construction activity occurred in February 1989.

2.3.1.2 High Endoatmospheric Defense Interceptor (HEDI)

The HEDI program demonstrates a technology that would employ ground-based missiles to intercept and destroy hostile RVs from SLBMs or ICBMs during the terminal phase of their trajectory (while in the high endoatmosphere).

The HEDI missile would consist of a two-stage booster and a KV with a conventional (non-nuclear) warhead. HEDI KITE flight tests at White Sands Missile Range use the existing first- and second-stage SPRINT boosters. HEDI is expected to use a booster similar to SPRINT, but with higher propellant weight. Debris from the tests would fall in the BOA.

Construction of facilities on Meck Island began in August 1988 and is scheduled for completion in October 1989. Flight testing of HEDI at USAKA would consist of one propulsion test vehicle flight (no target) and one experimental test vehicle flight (and MM I target launch from Vandenberg AFB or STARS target launch from the Pacific Missile Range Facility [PMRF] in Hawaii). The first flight is scheduled for the first quarter of 1993; the second flight is scheduled for the fourth quarter of 1993.

HEDI and SBI programs would share facilities on Meck Island. Construction for the HEDI/SBI programs includes a new Missile Assembly Building (MAB); a launch station (a 3-foot-thick concrete slab that is 273 feet long by 50 feet wide, in an area now asphalted); a launch equipment room and payload assembly building; and a KV fueling area. The site of the HEDI/SBI MAB is a small area of fill on the northeast side of the island protected by a seawall approximately 250 feet long and 10 to 15 feet high. Extensive renovations at the Meck Island Control Building would provide space for HEDI/SBI launch control and technical support. The HEDI program would also share some new and rehabilitated facilities with the ERIS program (as described below). An Environmental Assessment is being prepared for the HEDI program by the Strategic Defense Command. A Record of Environmental Consideration for the HEDI launch complex was issued on 28 November 1986 by the Corps of Engineers, Honolulu Engineer District.

2.3.1.3 Space-Based Interceptor (SBI)

The SBI program is a Demonstration/Validation (Dem/Val) program involving flight testing at USAKA. If deployed, the SBI system would be an orbiting space platform from which interceptor rockets could be launched at hostile intercontinental or submarine-launched ballistic missiles against an

earth background. In the Dem/Val phase the interceptor vehicle would be launched from the Meck Island launch facility with an ARIES booster system. The Dem/Val flight would test the SBI homing subsystem performance, guidance and control systems, and divert maneuver performance.

Two target missiles would be launched from Roi-Namur Island during the mission. The target missiles would use a STRYPI booster system, which consists of Castor IV, Antares III, and Star 27 motors. Interceptor and target collision debris would fall in the BOA.

Three test flights are scheduled in the third quarter of 1992 and the first and third quarters of 1993.

The SBI program would share some new and rehabilitated facilities on Meck Island, as described below. The SBI launch complex was the subject of a Record of Environmental Consideration issued in July 1987. An Environmental Assessment of the SBI Dem/Val program was issued in July 1987 by SDIO.

2.3.1.4 Facilities Jointly Used by ERIS and HEDI/SBI

A number of new facilities on Meck Island have been constructed for joint use by the ERIS and HEDI/SBI programs (Figure 2.3-4). These include a new water storage tank (250,000-gallon capacity, open concrete) to store rainwater that is collected from the runway catchment area and the roof of the Meck Island Control Building; a new breakwater, enlarged pier, and waiting shelter ("Small Craft Berthing Facility"); a camera transformer vault; a guardhouse; a freshwater pump house; three camera towers; and a new MMH Fuel Storage Building and associated 75-foot asphalted pavement.

Support facilities on Meck Island that are undergoing rehabilitation include the dining hall, guardhouse, freshwater filtration/treatment plant, septic tank/leach bed systems, and camera towers.

The Meck power plant has been reactivated and renovated. Five new 565-kW units were installed during mid-1989.

A new 6,000-square-foot warehouse to store ERIS and HEDI/SBI material has been constructed on Kwajalein just north of Lagoon Road adjacent to the JTO Building.

2.3.1.5 Ground-Based Surveillance and Tracking System (GSTS)

The GSTS would track ballistic missile targets in the midcourse phase and pass data through a ground-based data processor to the ERIS and other SDI elements. USAKA would

support flight testing of GSTS with launches from Omelek Island. Monitoring would be provided by ground-based USAKA range assets. Integrated testing with ERIS and other SDI programs is being planned.

Omelek Island, currently used to launch met rockets, would be the site of launches for the GSTS program (Figure 2.3-5). Construction is scheduled to begin in the period from 1992 to 1993 and would include the following elements:

- Two launch pads would be constructed in the area currently occupied by the met rocket pads. Ancillary equipment at the same site would include the missile umbilical masts (gantries), new launch equipment rooms, and a blast wall or berm separating the two launch pads to reduce fire hazards.

- The existing MAB would be rehabilitated or a new MAB would be constructed.

- Existing poles that support video cameras would be moved and/or modified to provide 360-degree coverage of dual launches. One tower might be moved offshore to the reef area.

- The existing breakwater, boat ramp, and pier would be strengthened; the existing harbor would be deepened.

- A blast berm might be constructed across the center of the island just north of the harbor area.

- An existing dirt track would be paved to provide access to facilities.

- Other likely construction would include quarters for 24-hour security, additional air-conditioning equipment, strengthening of the existing ordnance bunker, and repair or replacement of the existing power plant.

- A fiber optic cable would be laid from Omelek to Meck so that launches on Omelek could be effected by remote control.

A modified Polaris A3 or Poseidon C3, or equivalent two-stage solid rocket booster system, would be used to launch the GSTS payload from Omelek. Liquid propellant might be used in the payload vehicle for vector control. Booster segments would be flown into Kwajalein and barged to Omelek for assembly. Omelek would be vacated during GSTS launches and launches would be remotely controlled from Meck.

The GSTS launch would occur either simultaneously or immediately after an RV launch from Vandenberg AFB or PMRF. The GSTS payload would track the mid-course target and relay that information to ground stations for recording.

The first two GSTS missions would use targets of opportunity launched from Vandenberg AFB or PMRF. The last two missions (dedicated launches from Vandenberg AFB) would involve dual launches from Omelek to provide "stereo" GSTS views of the mid-course ICBM. Six launches from Omelek would take place between the fourth quarter of 1994 and the third quarter of 1997.

The GSTS payload, booster, and RVs would impact in the BOA. No hazardous or toxic materials would be contained in the GSTS payload. Fuels would be consumed and much of the debris from the flights would be burned up during reentry. An Environmental Assessment of the GSTS Dem/Val program was issued by SDIO in July 1987.

2.3.2 SENSING/TRACKING

A number of SDI testing programs at USAKA would involve sensing and tracking. All of the sensing/tracking programs involve RVs targeted to the USAKA area, and most would use the full range of USAKA's sensing/tracking and range support facilities.

2.3.2.1 Aerothermal Reentry Experiment (ARE)

The ARE is a program of four missions to monitor temperatures and pressures associated with the reentry of payloads launched from Vandenberg AFB and PMRF. Two of the RVs would be launched by dedicated boosters and two would be launched as part of another mission. Existing tracking and sensing facilities at USAKA would be used. The ARE program would provide data in support of the ERIS program.

The RVs would contain no hazardous materials, and they would impact in the BOA. Missions are planned between the second quarter of 1990 and the second quarter of 1992.

2.3.2.2 Airborne Optical Adjunct (AOA)

The AOA is a research program that uses a Boeing 767 aircraft modified to accommodate an LWIR optical sensor. The experiment is designed to provide data to resolve functional, hardware, and phenomenology issues related to the use of optics to track objects (including RVs) in the high endoatmosphere and exoatmosphere.

The AOA aircraft would fly to Kwajalein from its base in Seattle, Washington, for several missions per year, each requiring the aircraft's presence at USAKA for 2 to 3 weeks.

The AOA would track dedicated targets and targets of opportunity launched from Vandenberg AFB or PMRF.

USAKA would provide ground support, storage facilities, and telemetry (Figure 2.3-6). A liquid nitrogen plant has been constructed on Kwajalein to support the AOA instrumentation cooling system. USAKA would also provide storage for gaseous nitrogen, aviation grade breathing oxygen, and small quantities of hazardous materials. Handling and storage procedures for these gases and other materials will be in accordance with existing safety regulations and approved by the USAKA Range Safety Office. Existing Hot Spot No. 2 would be modified to include wiring for aircraft support units such as air-conditioning and power. A site located on the airfield apron would be available to accommodate the Mission Support Van (brought in by C-141). Several other existing buildings would be used, but would require little or no modification for the AOA. A record of environmental consideration dated May 1989 was prepared by the U.S. Army Strategic Defense Command.

Construction will be completed by the fourth quarter of 1989. AOA operations would begin in the fourth quarter of 1989 and are currently scheduled for one year.

2.3.2.3 Exoatmospheric Discrimination Experiment (EDX)

The EDX program consists of a series of ten launches in which the RV would impact in the USAKA range, either in the BOA or in the Kwajalein Lagoon. Each experiment would consist of the launch of a three-stage MM I missile from VAFB in California and an accompanying launch of an ARIES I sounding rocket from the PMRF. Only the target vehicle would reenter within the USAKA range.

The purpose of the program is to collect mid-course discrimination data. USAKA would provide support to the missions using existing radar, tracking, sensing, and RV recovery capabilities. No new facilities would be built at USAKA.

The first mission is scheduled to occur in the first quarter of 1992 and the last mission would be completed in the fourth quarter of 1995. No more than three missions would occur each year.

2.3.2.4 Ground-Based Radar-Experimental (GBR-X)

The GBR-X is a large phased-array radar that would track multiple targets in the mid-course and terminal phases. Three MM I missile missions launched from Vandenberg AFB during 1993 would be specific GBR-X targets. GBR-X would

also track any other launches or incoming RVs as targets of opportunity at USAKA (Figure 2.3-7).

The GBR-X radar is proposed for installation on top of the existing Building 1500 at the west end of Kwajalein Island. The building would require structural improvements, including the construction of an internal support tower and a foundation to support the radar. Power, air-conditioning, ventilation, and other mission support and control facilities would be installed within the building.

Building 1500 is now used for a USAKA Digital Microwave System antenna and radios. Physical interference from the GBR-X would require the antenna to be moved to another location. Several locations are being studied to determine the best location with regard to operational and environmental considerations. Building 1500 is also used for temporary storage of PCB transformers awaiting shipment to the United States for disposal. Before the start of GBR-X construction, this material would be relocated to a new temporary storage area.

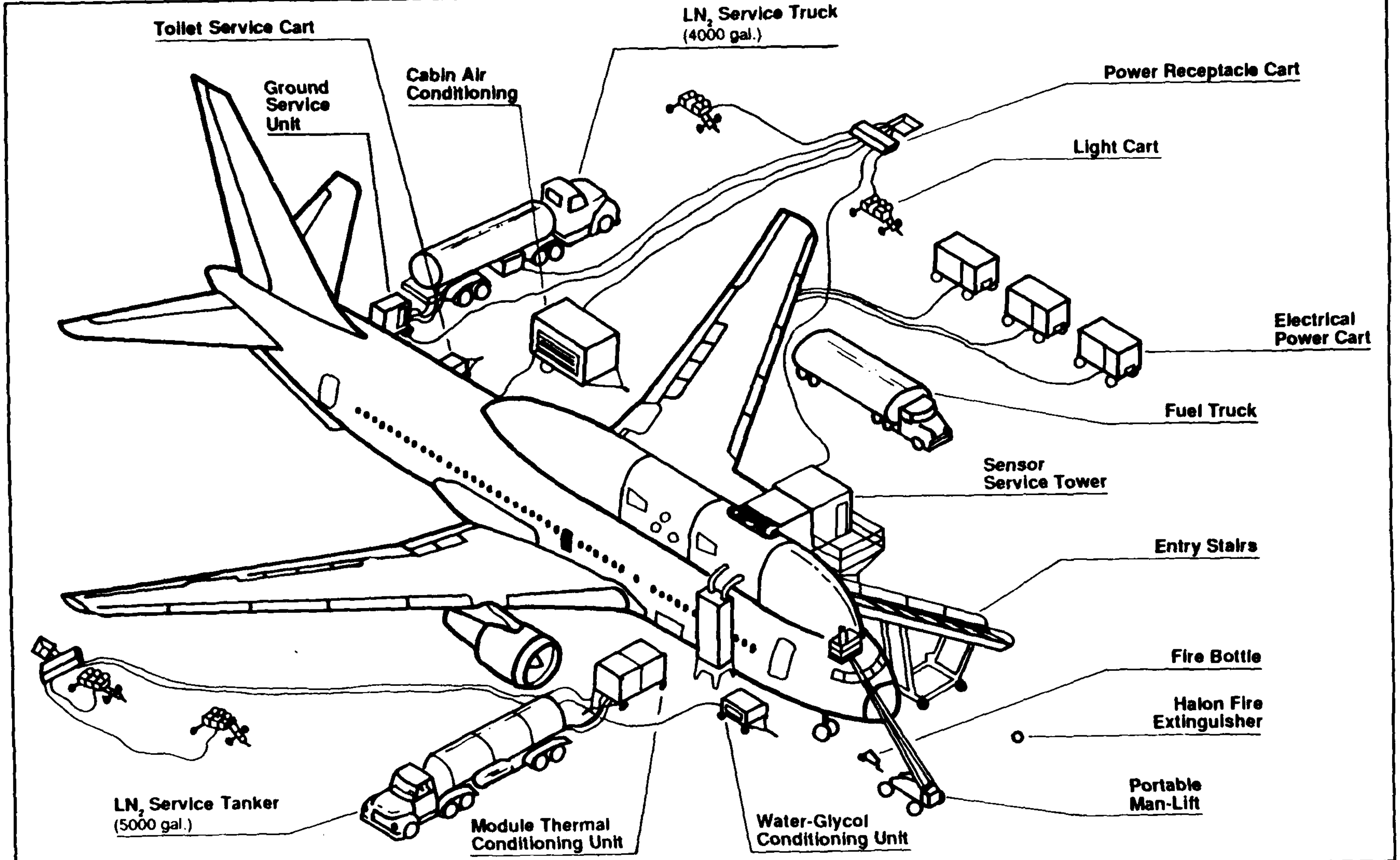
Construction of the GBR-X facilities is scheduled to begin in late 1989 and to be completed by late 1991, when radar installation would begin. Testing would begin in 1993. An Environmental Assessment of the GBR-X was prepared by USASDC in March 1989.

2.3.2.5 High Altitude Learjet Observatory and Infrared Instrumentation System (HALO/IRIS)

HALO and IRIS both make use of a specially equipped Learjet to collect visible and infrared data on incoming RVs and launches. The Learjet, based in Tulsa, Oklahoma, would fly to Kwajalein on five to ten missions per year, with each mission lasting 3 to 4 days. No construction or modification of USAKA facilities would be required to support the HALO and IRIS missions. Infrared signature data collection for seeker development and verification would continue throughout the Dem/Val phase of SDI systems. Data collection using the IRIS system began in July 1987.

2.3.2.6 Mid-Course Sensors Experiment (MSX)

The MSX would involve the launch of a single missile from the PMRF at Barking Sands Airfield, Kauai, into orbital flight during the first quarter of 1992. The flight would provide data on ICBM mid-course flight as well as phenomenology data. USAKA would provide sensing and tracking. No construction or modification of USAKA facilities would be required.



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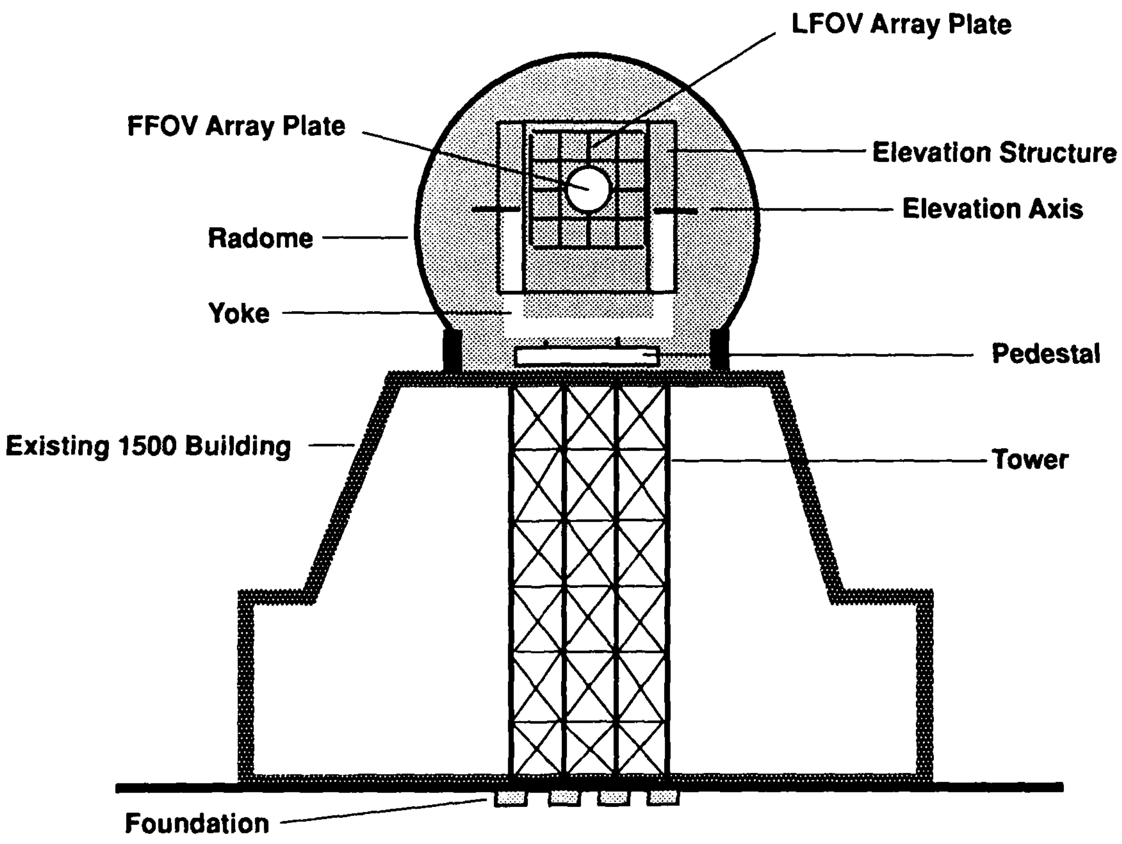
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

AOA AIRCRAFT AND GROUND SUPPORT EQUIPMENT

Figure 2.3-6



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GBR-X STRUCTURE

Figure 2.3-7

2.3.2.7 Optical Aircraft Measurement Program (OAMP)

The OAMP is an airborne infrared data collection system designed to gather data on objects of interest to the U.S. Army Strategic Defense Command. For tests at USAKA, the OAMP aircraft would be based at Hickam AFB in Hawaii. The OAMP system would be tested with missiles launched from Vandenberg AFB and targeted to USAKA. At the time of each mission, the aircraft would fly from Hawaii to the USAKA area, where it would remain airborne. The aircraft would circle USAKA, observe the missile reentry, communicate with specialized equipment at USAKA, and return to Hickam after the mission. The aircraft would not land at Kwajalein.

The program involves the installation of some specialized sensing equipment in existing facilities on USAKA. No construction would be required. Technicians installed the instrumentation during February 1989. OAMP uses targets of opportunity launched from Vandenberg AFB that began in the first quarter of 1989.

2.3.2.8 Project Cardinal

Project Cardinal would be a single launch of a missile from Vandenberg AFB during the fourth quarter of 1989. USAKA would track the RV to its targeted location in the BOA north of Roi-Namur, using existing range tracking and sensing facilities and personnel.

2.3.2.9 Strategic Target System (STARS)

STARS is a missile booster system to replace the dwindling supply of MM I boosters. The new STARS missile is a three-stage solid propellant booster system that uses selected parts of the retired Polaris A3 missiles with a third-stage modification, including an ORBUS I motor and ICMU guidance system. STARS would be launched from PMRF, and the RV would impact in the BOA or the Kwajalein Lagoon. USAKA's involvement would be target tracking and telemetry data collection, and RV recovery if the target impacts in the lagoon. No construction would occur at USAKA to support the STARS missions.

Up to 60 STARS missiles can be made available. As of February 1989, five STARS missile launches were scheduled: a demonstration launch (in October 1990), three launches for the ARE (in 1991 and 1992), and one launch for HEDI (in 1993).

2.3.3 RELATED ACTIONS: PROPOSED CONSTRUCTION

In addition to construction to support specific test programs (such as the SDI construction described above), construction in support of base operations has been an

important, ongoing activity at USAKA in recent years, amounting to approximately $20 million per year. Many of the buildings at USAKA were constructed in the 1950s and 1960s; a large share were constructed as "temporary" buildings; and all have suffered from the harsh sunlight, heavy rains, and salt air of the atoll. Most of USAKA's construction program involves the replacement of buildings that do not meet Army standards or that have been damaged or are in need of major rehabilitation. Construction in support of base operations currently follows the planning guidelines of the "U.S. Army Kwajalein Atoll Master Plan Report" (CH2M HILL and Belt Collins and Associates, 1988). This DEIS does not assess the Master Plan; however, the Army has requested funding to complete an environmental assessment of the Master Plan in the near future.

Several construction projects in support of base operations are proposed as actions related to the Proposed Action (Figures 2.3-2 and 2.3-3). The construction projects described below form the construction program planned for FY90 (i.e., October 1989 through September 1990), for which budget documents and plans are defined in sufficient detail for consideration in this DEIS. Several of these projects, as noted below, have been the subject of environmental analysis. They are discussed in this DEIS for the purpose of assessing their cumulative effects. Other construction projects in later years would require separate environmental review in compliance with NEPA before construction could begin.

2.3.3.1 Desalination Plant, Kwajalein

This project involves the construction of a 150,000-gallon-per-day (gpd) freshwater production facility, including desalination equipment and piping for the seawater intake and the distribution system. The project is budgeted for 1990.

2.3.3.2 Sewage Treatment Plant, Roi-Namur

A 70,000-gpd package sewage treatment plant (secondary treatment) is budgeted to begin construction in 1990. Currently, domestic sewage on the Roi (west) side of the island is kept in a holding tank before being pumped into the ocean. Sewage on the Namur (east) side uses septic tanks and leach fields.

2.3.3.3 Document Control Facility, Roi-Namur

A 5,250-square-foot semipermanent building would be constructed between the TRADEX and ALCOR facilities. The new structure would include a document control facility, air-conditioned office space, and an enclosed passageway between the two radar facilities. This project is budgeted for 1990. It was the subject of a Record of Environmental

Consideration approved by the Corps of Engineers, Honolulu Engineer District, on 31 August 1987.

2.3.3.4 Housing Projects

Family Housing, Kwajalein. One hundred thirty family housing units in 24 buildings are planned for an area along the northwest lagoon side of the island currently occupied by trailer housing. The new housing will consist of manufactured or factory-built two-story multiplex units on concrete-slab foundations. This construction is the second phase of a housing construction project begun in 1987, which added 136 family housing units by 1989. The second phase, scheduled to begin construction in 1991, may be financed through a third-party build-to-lease program.

Unaccompanied Personnel Housing, Kwajalein. New unaccompanied personnel housing comprising two 80,000-square-foot buildings, each housing 200 persons, is scheduled to be constructed in 1990. This project may also be financed through a third-party build-to-lease program. This project was the subject of an Environmental Assessment prepared by the Corps of Engineers, Honolulu Engineer District.

2.3.4 EMPLOYMENT AND POPULATION

The proposed SDI testing activities would require a modest increase in the number of operations workers at USAKA (Table 2.3-1). The proposed schedule for SDI testing shows the additional nonindigenous workforce peaking in 1992 and 1993 with 147 additional permanent personnel (110 accompanied and 37 unaccompanied), an average of 36 transient personnel (who would work at USAKA for no more than an average of 10 weeks each year). The peak increase in the nonindigenous population attributable to SDI (including dependents and adjusting for the temporary presence of transient workers, but excluding up to 75 temporary construction workers) is expected to be 403, reflecting a 14 percent increase over the nonindigenous population of late 1988 (excluding construction workers). No other increase in base operations and range support personnel is anticipated; therefore, no increase directly attributable to the SDI programs is expected in the indigenous workforce or population.

Table 2.3-1
PROPOSED ACTION
PERSONNEL AND POPULATION EQUIVALENTS

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
PERSONNEL										
Accompanied[a]	24	31	34	110	110	85	5	5	0	0
Unaccompanied	0	4	10	37	37	33	0	0	0	0
Transient[b]	5	24	30	36	36	27	5	5	0	0
POPULATION EQUIVALENTS										
Accompanied[a]	72	93	102	330	330	255	15	15	0	0
Unaccompanied	0	4	10	37	37	33	0	0	0	0
Transient[b]	5	24	30	36	36	27	5	5	0	0
TOTAL	77	121	142	403	403	315	20	20	0	0

[a] Accompanied personnel are assumed to have two dependents (based on historical trends).

[b] Transient personnel are conservatively assumed to spend approximately 10 weeks at USAKA. The number reported here represents 20 percent of the total number of transient personnel days, rounded to the nearest whole number.

Source: Personal communication, USASDC, Huntsville, 22 March 1989.

2.4 CHANGE OF DURATION ALTERNATIVE

The Change of Duration Alternative assumes that some major SDI programs would be delayed to reduce the level of activities at USAKA (including the number of personnel and associated demands on base operations). Major SDI programs are defined for this alternative as programs that have potential environmental effects because of the nature of the missions or because of the increase in the workforce and related transportation, facilities, and other support functions. Examples of major SDI programs are launch programs such as ERIS, HEDI, GSTS, SBI, and radar programs such as GBR-X. SDI programs that consist of sensing and tracking, or the lagoon or land impact of RVs are not considered as major SDI programs for the purpose of this alternative, as the potential environmental effects are minimal.

The Change of Duration Alternative assumes that overall SDI funding would continue at a constant rate and that research and development of specified SDI programs would continue in a sequence based on program priority or the current stage of development of the technology. The schedules of ERIS, SBI, and GSTS tests would not change.

2.4.1 PROGRAM SCHEDULES

The specific program schedules affected by the Change of Duration Alternative are HEDI and GBR-X (as shown in Figure 2.2-2). The initial test flight schedule for HEDI would be changed from the period 1993 to 1996 in the Proposed Action to begin in the third quarter of 1998. GBR-X facilities would be constructed on the same schedule as in the Proposed Action, but operations would be delayed by 2 years, to begin in 1995.

2.4.2 EMPLOYMENT AND POPULATION

Under the Change of Duration Alternative, SDI testing would require a smaller workforce for a longer period of time than under the Proposed Action. Related population impacts would also be smaller, but would occur over a longer period, as shown in Table 2.4-1.

At its peak in 1996 and 1997, the SDI operations personnel at USAKA would be expected to comprise 69 permanent personnel, consisting of 61 accompanied and 8 unaccompanied, and an average of 10 transient personnel who are assumed to be at USAKA for 10 weeks each year. The peak nonindigenous population impact, including dependents and adjusting the transient personnel count to reflect the short-term duration of their presence at USAKA, is projected to be 201, reflecting a 7 percent increase over the nonindigenous population in late 1988.

Table 2.4-1
CHANGE OF DURATION ALTERNATIVE
PERSONNEL AND POPULATION EQUIVALENTS

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
PERSONNEL										
Accompanied[a]	24	31	31	31	34	29	28	61	61	56
Unaccompanied	0	4	4	4	10	25	25	8	8	8
Transient[b]	5	24	29	26	21	25	10	10	10	5
POPULATION EQUIVALENTS										
Accompanied[a]	72	93	93	93	102	87	84	183	183	168
Unaccompanied	0	4	4	4	10	25	25	8	8	8
Transient[b]	5	24	29	26	21	25	10	10	10	5
TOTAL	77	121	126	123	133	137	119	201	201	181

[a] Accompanied personnel are assumed to have two dependents (based on historical trends).

[b] Transient personnel are conservatively assumed to spend approximately 10 weeks at USAKA. The number reported here represents 20 percent of the total number of transient personnel days, rounded to the nearest whole number.

Source: Personal communication, USASDC, Huntsville, 22 March 1989.

2.5 COMPARISON OF ALTERNATIVES AND MITIGATION

Impacts of the two action alternatives and the No-Action Alternative differ in several areas. The following subsection describes the extent to which each meets the purpose and need for the Proposed Action. It then compares major differences among the alternatives' environmental impacts, and where significant impacts have been identified, describes the mitigation measures that are part of the alternatives and other potential mitigation measures. Environmental impacts and mitigation are summarized in Figure 2.5-1.

2.5.1 MEETING THE NEED FOR THE PROPOSED ACTION

Under the No-Action Alternative, no new SDI-related construction or Dem/Val testing would occur at USAKA. Because USAKA is the only reasonable site for field testing of the Strategic Defense System, major elements of the SDI program could not be developed under the No-Action Alternative, and the development of a Strategic Defense System as a viable defense option would be jeopardized.

The Proposed Action would accomplish a critical step in the testing of SDI elements, following the schedule established to assure the timely development of a Strategic Defense System.

The Change of Duration Alternative would have a detrimental effect on the overall SDI program. Both the HEDI and GBR-X programs are central elements of SDI testing. The data gained from the GBR-X and HEDI tests are important in themselves, but are also critical for other SDI testing activities (for example, the GBR-X would be tested at USAKA not only to evaluate its own capabilities, but also for sensing and tracking of other SDI launches and reentry vehicles). Implementing the Change of Duration Alternative could compromise the timely development of a Strategic Defense System as a major element of the nation's defense forces.

2.5.2 ENVIRONMENTAL IMPACTS AND MITIGATION

For comparison, potential impacts can be grouped into a few broad areas.

Land and Sea Resources. The No-Action Alternative is not expected to have significant adverse effects on land or reef resources. Untreated sewage effluent at Roi-Namur has a detrimental effect on marine water quality in the immediate vicinity of the outfall. Current hazardous and solid waste management practices have some potential to affect groundwater and marine water quality. In addition, the freshwater supply from the Kwajalein Island lens well system is at risk of contamination by saltwater from heavy pumping during

drought periods when the freshwater catchment system provides insufficient supply.

The Proposed Action and the Change of Duration Alternative could increase the risks of groundwater and marine water contamination because of inadequate solid and hazardous waste practices. It could also increase the risk of saltwater contamination of the Kwajalein Island lens well system as a result of the increased drinking water demand from the higher population. Those risks would be somewhat lower in the Change of Duration Alternative because of its smaller increase in population.

The construction of a desalination plant on Kwajalein, proposed as part of the Proposed Action and Change of Duration Alternative, would mitigate impacts to the freshwater lens system from saltwater contamination. The construction of the package sewage treatment plant on Roi-Namur would mitigate the effects of untreated effluent. Impacts to ground and marine water quality could be mitigated through improved waste management practices.

<u>Air Quality and Noise</u>. The operations of existing Power Plant 1 and the solid waste burning pit on Kwajalein are estimated to produce localized air quality impacts exceeding air quality standards. In addition, noise from Power Plant 1 is estimated to result in noise levels exceeding standards for residential areas. Under both the Proposed Action and the Change of Duration Alternative, the increases in solid waste burned and power plant operations to support increased personnel would exacerbate the existing localized air quality exceedances on Kwajalein. The new Power Plant 1A on Kwajalein Island is also predicted to contribute to air quality standard exceedances and noise in residential areas.

Air quality impacts could be mitigated by monitoring and source testing, followed by additional air quality controls, reduced power plant operations, increases in stack heights, and installation of a solid waste incinerator with appropriate air pollution controls. Noise impacts could be mitigated by the installation of standard residential-type exhaust silencers.

<u>Biological Resources</u>. The native flora and fauna of the land and reef areas of USAKA have been extensively altered by man. Populations of rare giant clams may be stressed by ongoing USAKA activities. The increase in activities at USAKA under the two action alternatives could increase the stress on the remaining populations. Mitigation could include USAKA regulations prohibiting the taking of giant clams. Consideration will also be given to transplanting giant clams away from areas where they might be damaged by USAKA activities.

Environmental Resource	No Action		Proposed Action		Change of Duration Alternative	
	Regional[1]	Local[2]	Regional[1]	Local[2]	Regional[1]	Local[2]
Land and Reef Resources	○		○		○	
Groundwater		●		● M		● M
Marine Water Quality		●		● M		● M
Air Quality		●		● m		● m
Noise		●		● m		● m
Island Plants				● m		● m
Island Animals				○		○
Marine Biological Resources	○		○	● m	○	● m
Rare, Threatened, or Endangered Species		●		● m		● m
Archaeological Resources		○		● m		● m
Historical Resources		○		○		○
Land Use						
Population: Nonindigenous			○		○	
Population: Marshallese						
Employment: Nonindigenous			*		*	
Employment: Marshallese						
USAKA Housing	●		● M		● M	
Income/Fiscal Conditions	*		*		*	
Health, Education, Recreation						
Transportation			○		○	
Water Supply		●		● M		● M
Wastewater		●		● M		● M
Solid Waste	●		● m		● m	
Hazardous Materials/Waste	●		● m		● m	
Energy			○		○	
Aesthetics						
Range Safety						
Electromagnetic Radiation						

LEGEND

- ● Significant Negative Impacts
- ○ Insignificant Negative Impacts
- m Potential Mitigation
- M Mitigation as Part of the Alternative
- * Positive Impact

Notes: Blank = No Impact
Please review the text of Section 2.5 for an explanation of the impacts and mitigations summarized here.

[1] Regional Impacts: More than one island and/or large area affected.
[2] Local Impacts: Only one island and/or localized effects expected.

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

COMPARISON OF ALTERNATIVES, IMPACTS, AND MITIGATION

Figure 2.5-1

The construction of launch facilities on Omelek under the Proposed Action and Change of Duration Alternative has the potential to remove part of one of three stands of native trees on Omelek. This potential impact could be mitigated by siting the new facilities to avoid the stands of trees or by transplanting trees.

Land Use and Aesthetics. No significant impacts to land uses or visual resources of USAKA are predicted from any of the alternatives.

Socioeconomic Conditions. Under the No-Action Alternative, the nonindigenous population of USAKA is expected to remain close to the December 1988 level of 2,972. In the Proposed Action, the population would increase by as much as 403 (in 1992 and 1993, excluding temporary construction workers) before dropping to an increment of 315 in 1994, 20 in 1995 and 1996, and zero in 1997 and beyond. In the Change of Duration Alternative, population would increase by 201 (in 1996 and 1997).

Under the No-Action Alternative, a shortage of 130 family housing units is predicted to begin in 1992, as substandard trailers are retired. Under the Proposed Action, the deficit of family housing would increase to 240 in 1992 and 1993 and then decline. Under the Change of Duration Alternative, the deficit would peak in 1996 and 1997 at 191. The deficit in family housing would be partially mitigated under the two action alternatives through the construction of the proposed 130 new units of family housing.

Under the No-Action Alternative, a deficit of 607 unaccompanied family housing units is predicted. Under the Proposed Action, this deficit would grow to 644 by 1992 before dropping to 597 by 1995. Under the Change of Duration Alternative, the deficit would peak at 632 in 1994 and 1995, but then drop more rapidly than in the Proposed Action. This deficit in unaccompanied housing would be partially mitigated by the proposed construction of 400 new units.

No significant changes in the employment of Marshallese citizens at USAKA are expected from any of the alternatives. The action alternatives are not likely to lead to changes in the Marshallese population of the atoll.

Archaeological and Historical Resources. Ongoing activities may disturb subsurface archaeological and cultural resources and may expose historical resources to disturbance by the public. The action alternatives may increase the potential for disturbance to these resources. In addition, depending on final siting, the proposed launch facilities on Omelek have the potential to disturb an archaeological site. Mitigation could include avoiding siting the new facilities at

the archaeological remains or a preconstruction program of data analysis and recovery.

Transportation and Utilities. Transportation systems at USAKA are adequate for existing needs and are not predicted to be significantly affected by either of the two action alternatives.

The freshwater lens system at Kwajalein may prove inadequate in either of the two action alternatives as a result of increases in population. This shortcoming would be mitigated by the installation of the proposed desalination plant.

The Kwajalein Island wastewater treatment plant is reaching its hydraulic capacity. Increased demand on the wastewater system under either of the action alternatives could result in periodic discharges of excessive suspended solids and exceedances of BOD standards. This impact could be mitigated by water conservation and/or the installation of additional biological reactor capacity and an additional clarifier.

Mitigations for the two action alternatives include water conservation and the installation of a new package sewage treatment plant on Roi-Namur. This would eliminate the current discharge of untreated effluent.

Current USAKA solid and hazardous waste-handling practices are deficient in a number of areas. The volume of materials subject to these inadequate practices would increase under either of the action alternatives. Mitigation would include improved facilities and procedures to assure compliance with applicable standards.

Energy consumption would increase under the two action alternatives. Construction of Power Plant 1A on Kwajalein and renovation of the Meck power plant (now under way) will assure that adequate generating capacity is available.

Range Safety and Electromagnetic Radiation. No significant effects on range safety or hazards or interference from electromagnetic radiation are predicted from any of the alternatives.

2.6 ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD

Two alternatives were examined early in the scoping process but were eliminated from further consideration as unreasonable. The following subsections briefly describe the two alternatives and discuss why they were eliminated.

2.6.1 REDUCED ACTIVITIES

An alternative that would involve reducing or eliminating missile testing in the Pacific Ocean region was considered. A reduced activities alternative assumes that the national test range facilities and activities at USAKA would be terminated, and that no other Pacific Ocean test range would replace USAKA. In this alternative, missile testing and other sensing/tracking activities in the Pacific Ocean would be curtailed or eliminated.

Missile flight testing is an essential part of developing defense systems and maintaining a credible defense. Operational testing of intercontinental ballistic missiles and submarine-launched ballistic missiles is essential for assessing strategic readiness and for ensuring that strategic systems form a strong, dependable deterrent. The location of USAKA is a critical factor for missile testing because it provides security and a high degree of safety. In addition, the Pacific Ocean's great distances allow the testing of intercontinental ballistic missiles at their maximum ranges. This combination of factors makes a Pacific Ocean missile test range a critical component of national defense research and testing. A Pacific Ocean testing site is also critical for tracking the space shuttle and other United States and foreign space objects and for monitoring foreign missile launches. The alternative of reducing or eliminating missile testing and the other sensing/tracking activities now carried out at USAKA is, therefore, not a reasonable alternative, and is not examined further in this DEIS.

2.6.2 RELOCATION OF MISSILE RANGE AND SDI ACTIVITIES

Relocating the facilities and functions of USAKA to another part of the Pacific Ocean was also examined. This relocation alternative was the subject of a study prepared a decade ago by the U.S. Army Ballistic Missile Defense Systems Command, Kwajalein Missile Range Directorate, Analysis of the Relocation of Kwajalein, Volumes I-III, 1979 (the "ARK study"). The 1979 study identified alternative sites and evaluated them with respect to a number of factors, including support requirements, safety, and political stability.

Nine potential sites were identified initially. Four sites were eliminated in an evaluation against range user requirements. A preliminary site layout was prepared for the remaining five sites, and their suitability as a test site was ranked. Three likely candidates (Namonuito Atoll, Northern Mariana Islands Site No. 1, and the Phoenix Islands) were further evaluated (see Figure 1.1-1).

Although the ARK study found sites that could technically support the relocation of at least some elements of the USAKA mission, successful negotiation of the Compact of Free Association (Compact) terminated the search. The Compact and other long-term agreements allow the United States to use portions of Kwajalein Atoll for missile and other defense-related purposes in return for monetary payments to the RMI and a commitment to defend the RMI against foreign aggression.

The real property investment alone by the U.S. government at USAKA already stands at one-half billion dollars. Relocation would clearly be a major expense. The relocation of the USAKA mission is also questionable for political reasons. The signing of the Compact and other long-term agreements with the RMI government obligates the U.S. to provide support to RMI for the foreseeable future, regardless of whether the U.S. continues to use USAKA.

Further, USAKA is one of only two U.S. test ranges named in the Anti-Ballistic Missile Treaty as sites for the field-testing of land-based ABM components or systems such as those envisioned for use in SDI. The U.S. can use USAKA for field-testing of land-based ABM systems and components and comply with the ABM Treaty.

Finally, relocating the facilities and functions at USAKA would seriously delay the SDI program. The planning, programming, and budgeting required for relocation would take at least 5 years. Designing, contracting, constructing, and mobilizing a new test range would take many years. The entire process would be subject to negotiations with foreign governments for the right to use their property. These delays would push the SDI testing activities beyond the time when they are needed to support a full-scale SDI development decision, and would disable SDI as a viable defense option.

For all of the reasons above, relocation was not considered a reasonable alternative and is not examined further in this DEIS.

Chapter 3
AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the natural and man-made features of the environment that may be affected by the Proposed Action or alternatives. The affected environment includes the air, land, reef, lagoon, and ocean areas of the 11 USAKA islands. The non-USAKA islands of Ebeye and Ennubirr, where most of the Marshallese who work at USAKA reside, may also be affected and are discussed in some of the following sections, as appropriate. Other islands in Kwajalein Atoll are not expected to be affected and, therefore, are not considered part of the affected environment for this DEIS.

Kwajalein Atoll's environment is the product of millions of years of natural development, followed by a brief but critical period of human influence. The Japanese occupation from the end of World War I until 1944 initiated a period of intense change. During World War II, the atoll, and particularly Roi-Namur and Kwajalein Islands, were subjected to severe air, land, and sea bombardment (Figure 3.1-1). After World War II, the U.S. Navy used the atoll as a base to support the Korean conflict and weapons testing during the 1940s and 1950s. Construction and change have continued on Kwajalein Atoll through the 1980s.

More than half a century of change has affected the atoll unevenly. Several Kwajalein Atoll islands, including Kwajalein, Roi-Namur, Meck, and Ebeye, are now dominated by man-made features. Other islands (such as Legan and Eniwetak and many of the non-USAKA islands) continue to exhibit predominantly natural features.

Characteristics of the islands vary considerably, as reflected in Table 3.1-1. Ennugarret Island is not inhabited, has no USAKA facilities, and no USAKA activities are proposed there; it is included in the discussion of the affected environment because it is controlled by USAKA in order to prevent hazardous human exposure to the radars of nearby Roi-Namur. Information about Ennugarret is presented in only a few of the following resource descriptions. Conversely, discussions of Kwajalein Island present a far greater level of detail because it is USAKA s headquarters and the location of the largest workforce in the atoll.

The following sections are organized by major resource groups. Within each section, introductory material defines the resource and identifies the region of influence (which varies among resources). Relevant elements of the affected environment are then discussed. Unique and characteristic features of particular islands are highlighted in tables or in text. Figures 3.1-2 to 3.1-11 illustrate the natural resources of each island; figures in later sections of this chapter illustrate man-made features.

Table 3.1-1
CHARACTERISTIC FEATURES OF SELECTED KWAJALEIN ATOLL ISLANDS

Characteristic	USAKA Islands											Non-USAKA Islands	
	Kwajalein	Roi-Namur	Meck	Ennylabegan	Legan	Illeginni	Gagan	Gellinam	Omelek	Eniwetak	Ennugarret	Ebeye	Ennubirr
Marshallese Spelling	Kuwajleen	Ruot-Nimur	Meik	Aneellap-kan	Ambo	Likijjine	Kowak-kan	Kiden-en	Komle	Ane-wetak	Ane-karan	Epja	Ani-bon
Area (acres)	748	398	55	124	18	31	6	5	8	15	24	74	20
Population	Total Nonindigenous Population on Kwajalein, Roi-Namur, and Meck: 2,972 (12/88)			67 Marshallese	------------------------------------No permanent population--------------------------							8,277 Marshallese	494 Marshallese
USAKA Activities	Base headquarters; launches; radars; optical sensing; communications; range support; base operations; housing; community support	KREMS radar tracking; launches; optical sensing; range support; base operations; bachelor housing; community support	Launches; optical sensing; range support	Portion of the island leased by USAKA and used for telemetry, optical sensing	Optical sensing; radar	Land impact area; radar; optical sensing; telemetry	Optical sensing; telemetry	Radar; hydroacoustic impact timing system	Met rocket launches	Optical sensing	No activities	No direct USAKA activities; residence of indigenous workforce	
Facilities/ Buildings	Extensively built up with range support and base facilities, housing, and community support	Largely built up with range support and base facilities and housing	Extensively built up with range support and base facilities, breakwater, and pier	Helipad, antennas and buildings; two small Marshallese settlements; pier	Helipad, camera tower, short roads, finger jetty	Helipad, road, radars, camera towers, antennas, old launch facilities, jetty	Helipad, camera towers, antennas, marine ramp, personnel pier	Helipad, radars, other small buildings, harbor	Helipad, launch pads, missile assembly building, roads, marine ramp, and pier	Helipad, camera towers: two developed sites linked by a road	No facilities	Highly built up urban environment	Concrete block housing, pier

KWAJALEIN , FEBRUARY 1944

ROI-NAMUR, FEBRUARY 1944

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ENVIRONMENTAL IMPACT STATEMENT
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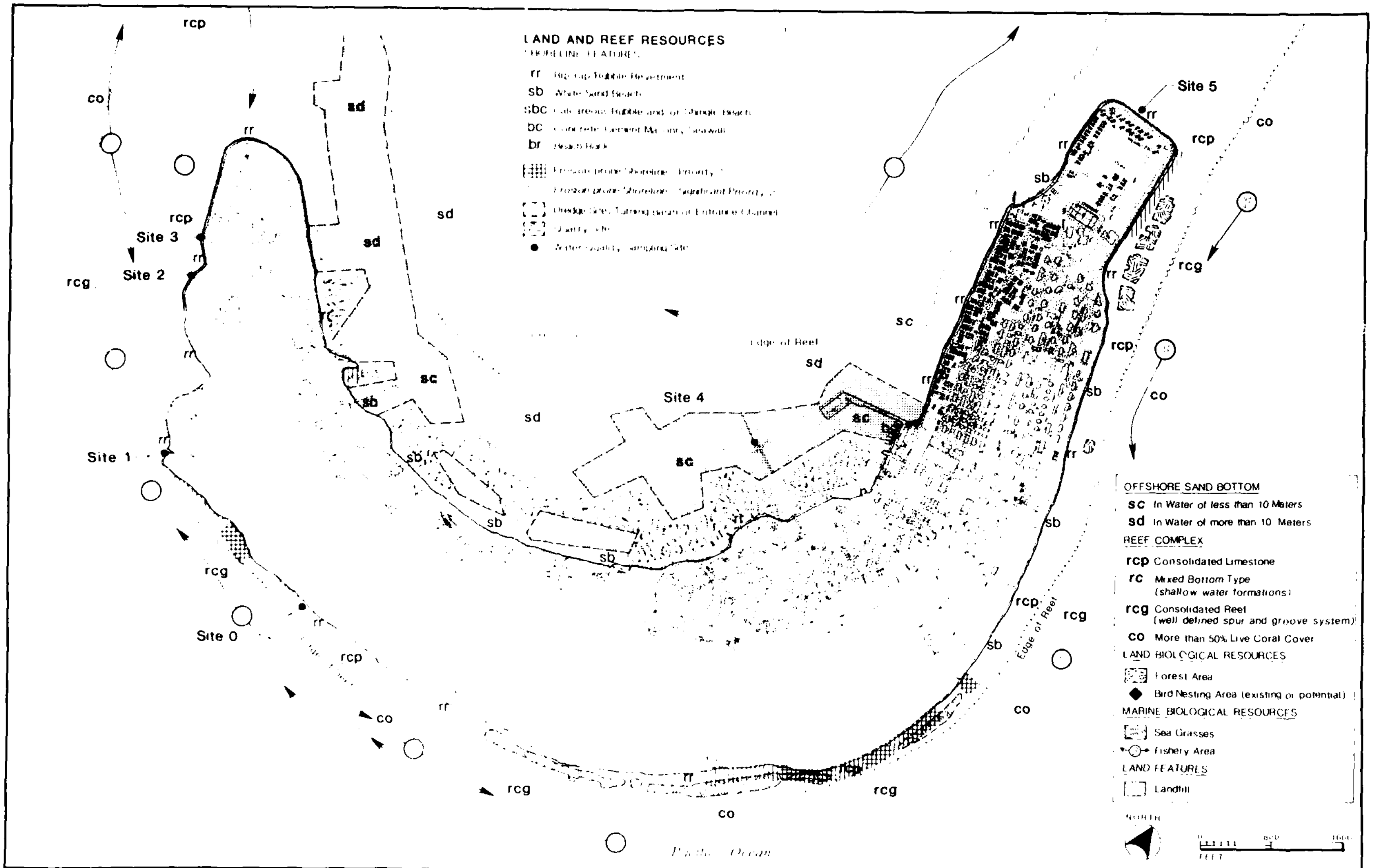
KWAJALEIN AND ROI-NAMUR AFTER WWII BOMBARDMENT

Figure 3.1-1



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ENVIRONMENTAL IMPACT STATEMENT
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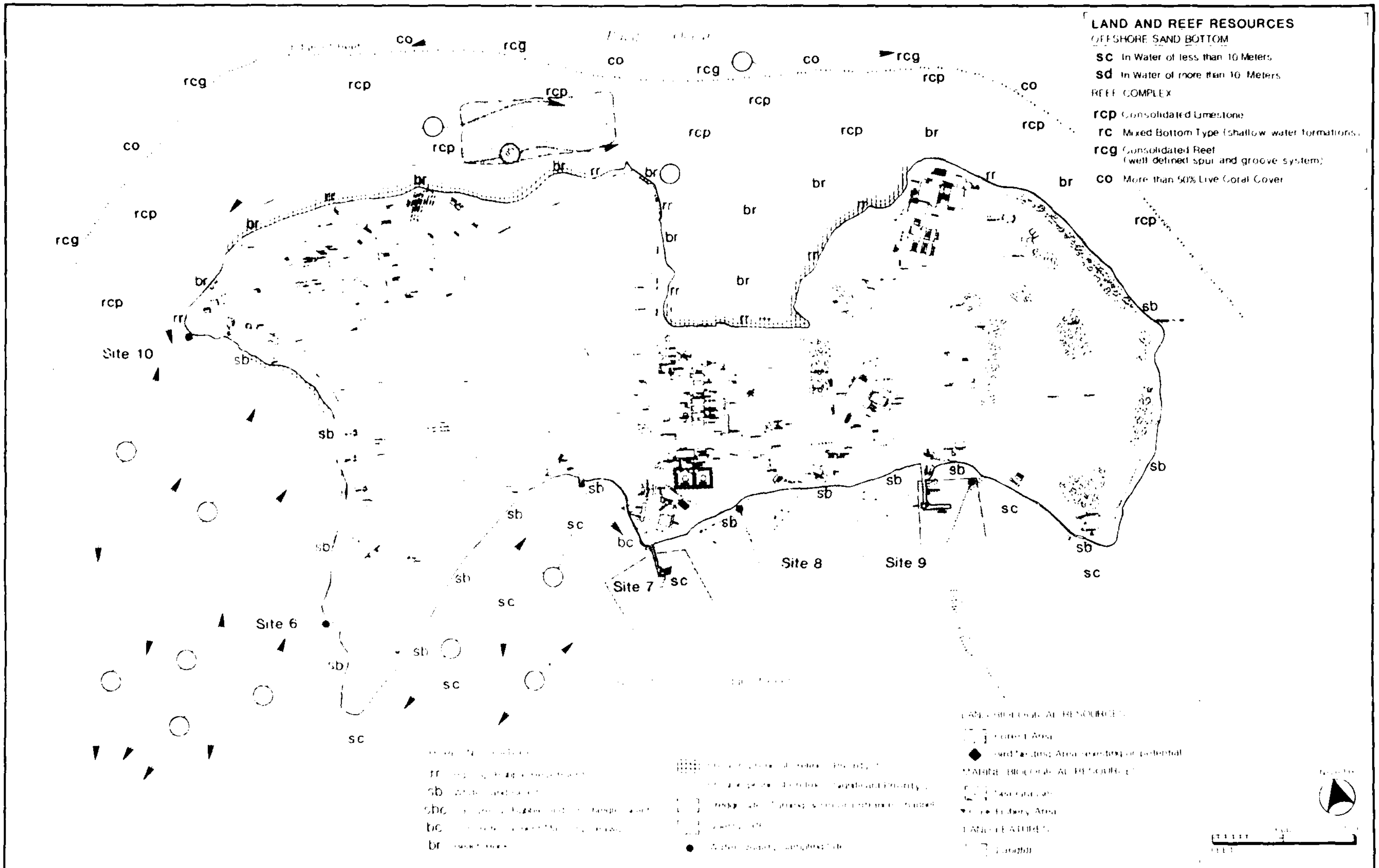
LAND AND REEF RESOURCES

KWAJALEIN ISLAND

Figure 3.1-2



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ENVIRONMENTAL IMPACT STATEMENT
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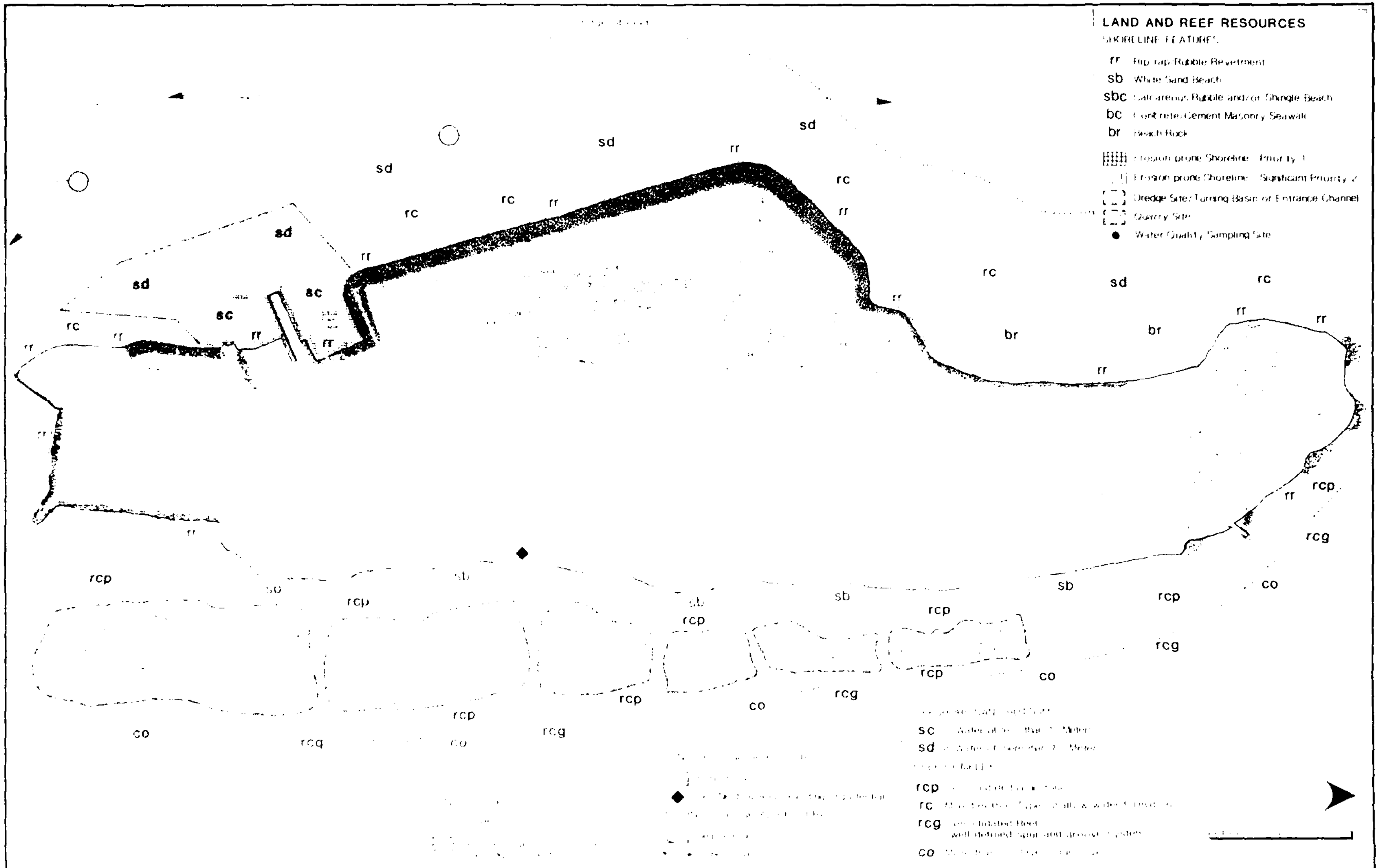
LAND AND REEF RESOURCES

ROI-NAMUR ISLAND

Figure 3.1-3



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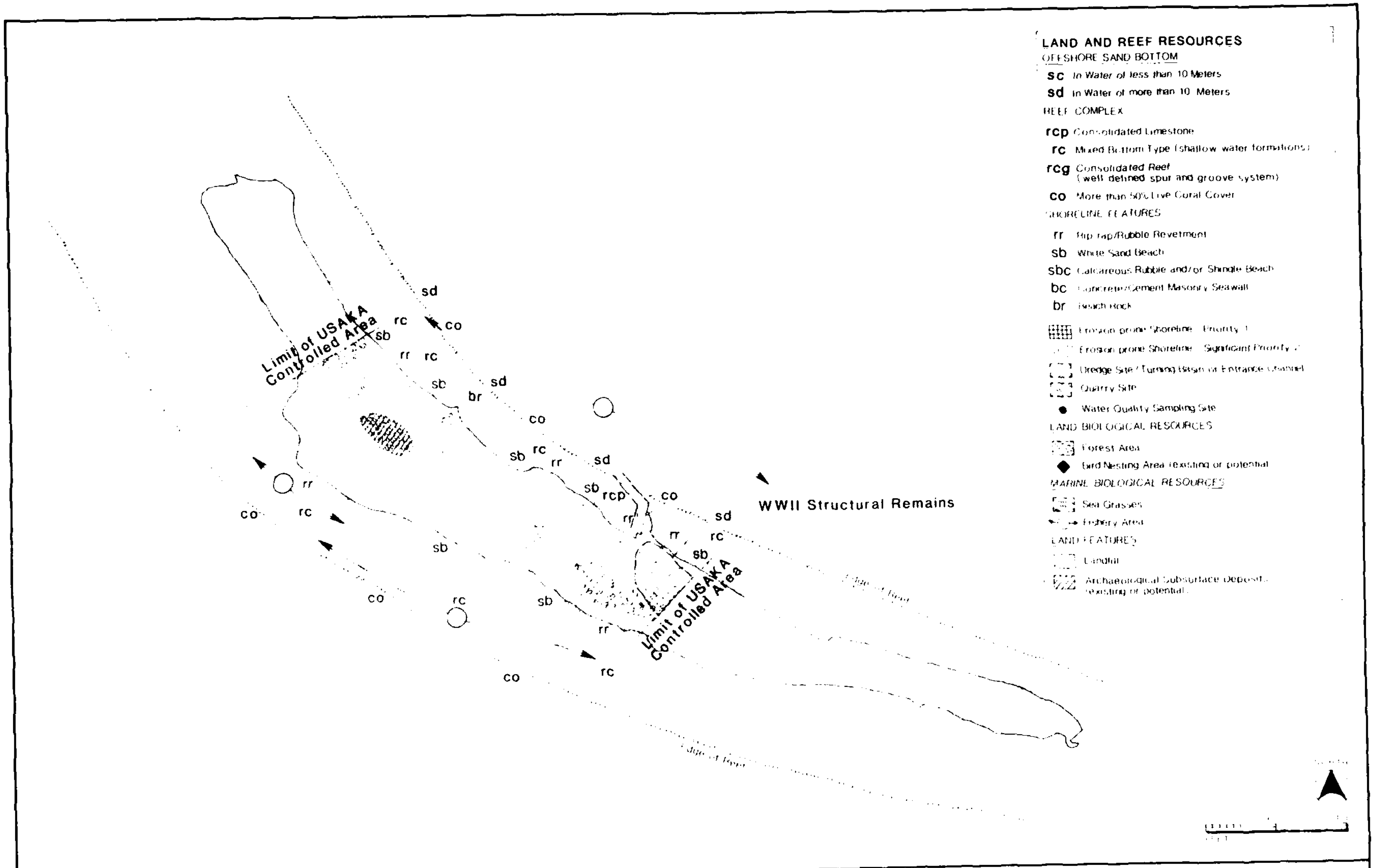
LAND AND REEF RESOURCES
MECK ISLAND

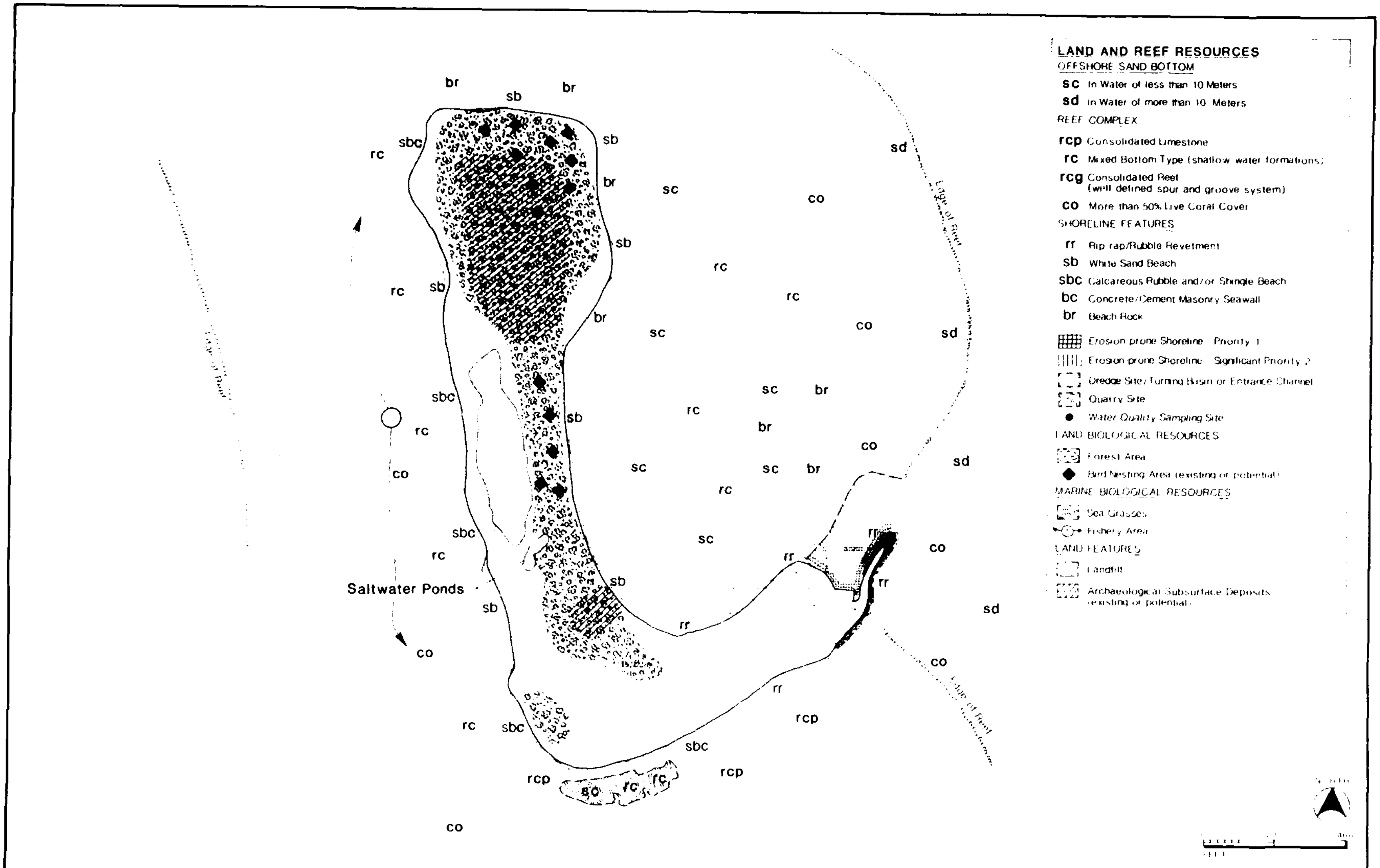
Figure 3.1-4



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES
ENNYLABEGAN ISLAND

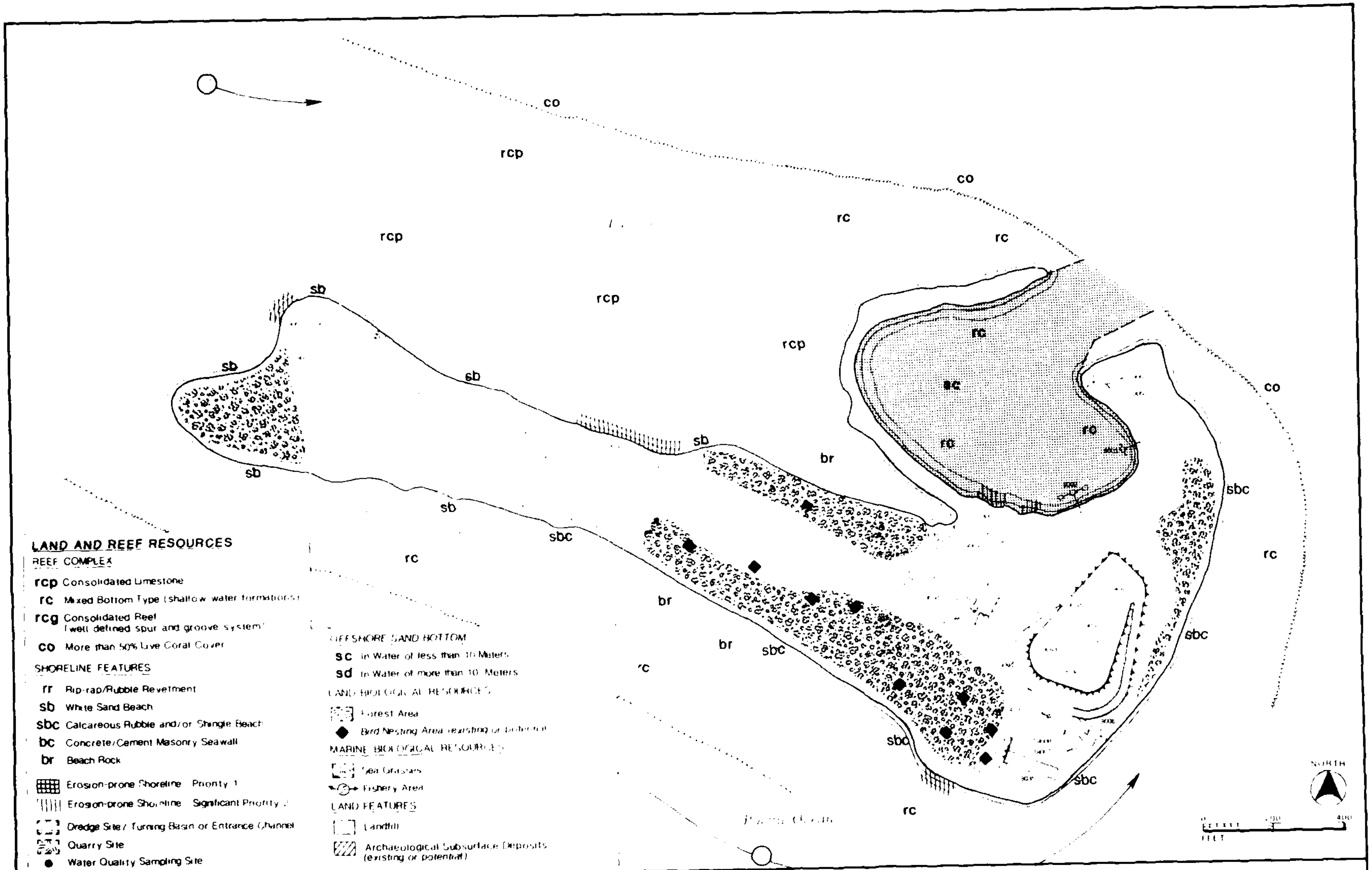
Figure 3.1-5



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES
LEGAN ISLAND

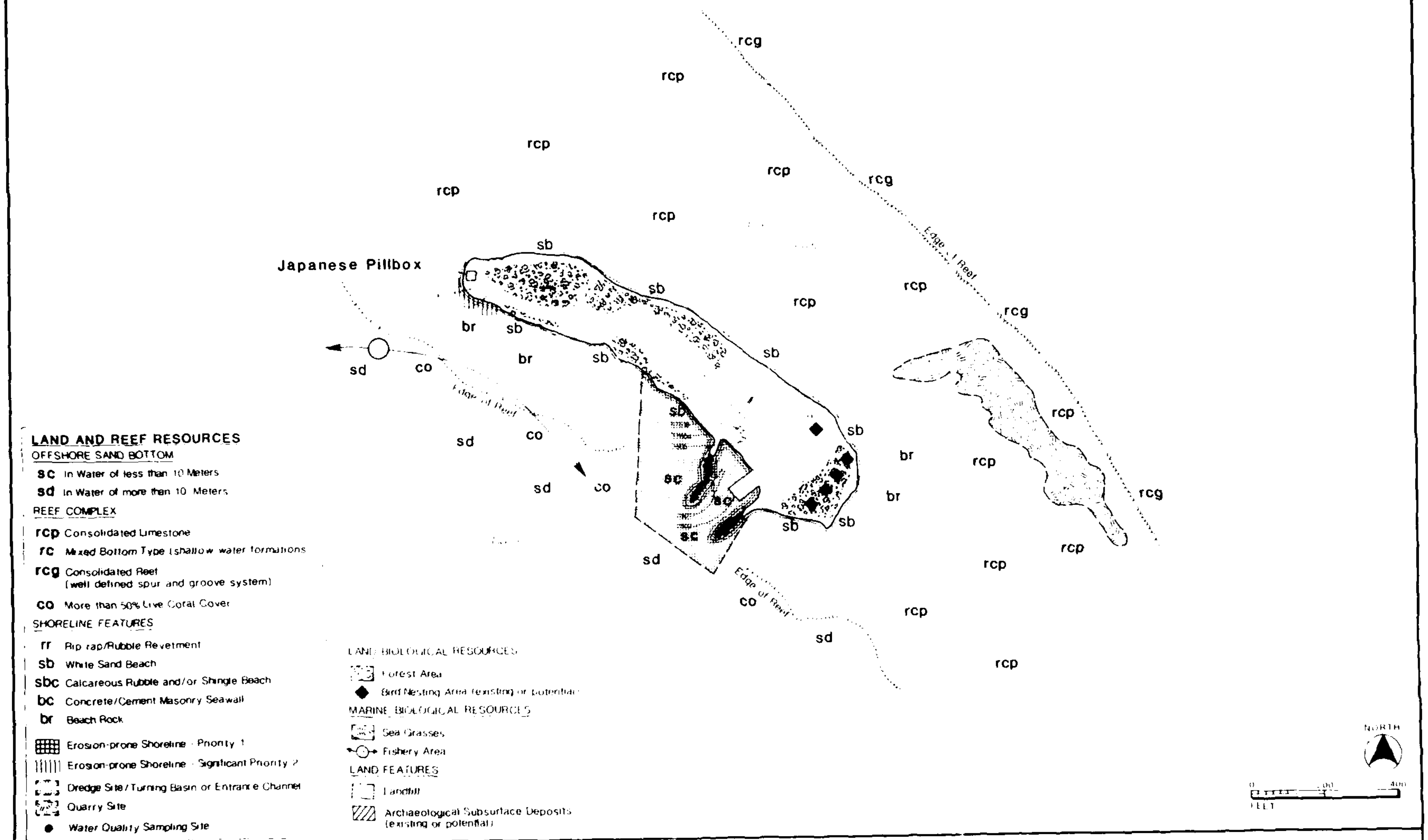
Figure 3.1-6



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES
ILLEGINNI ISLAND

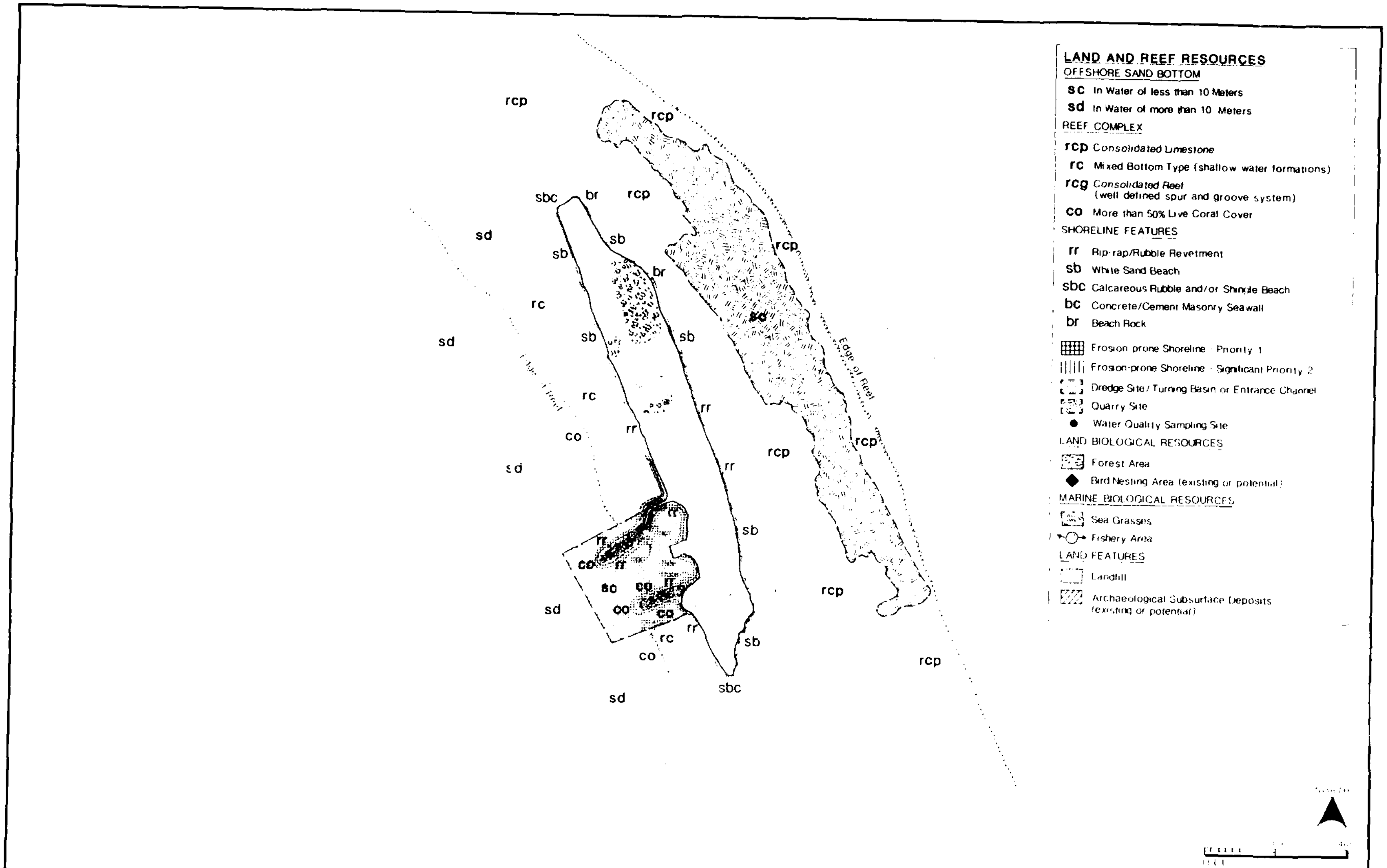
Figure 3.1-7



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES
GAGAN ISLAND

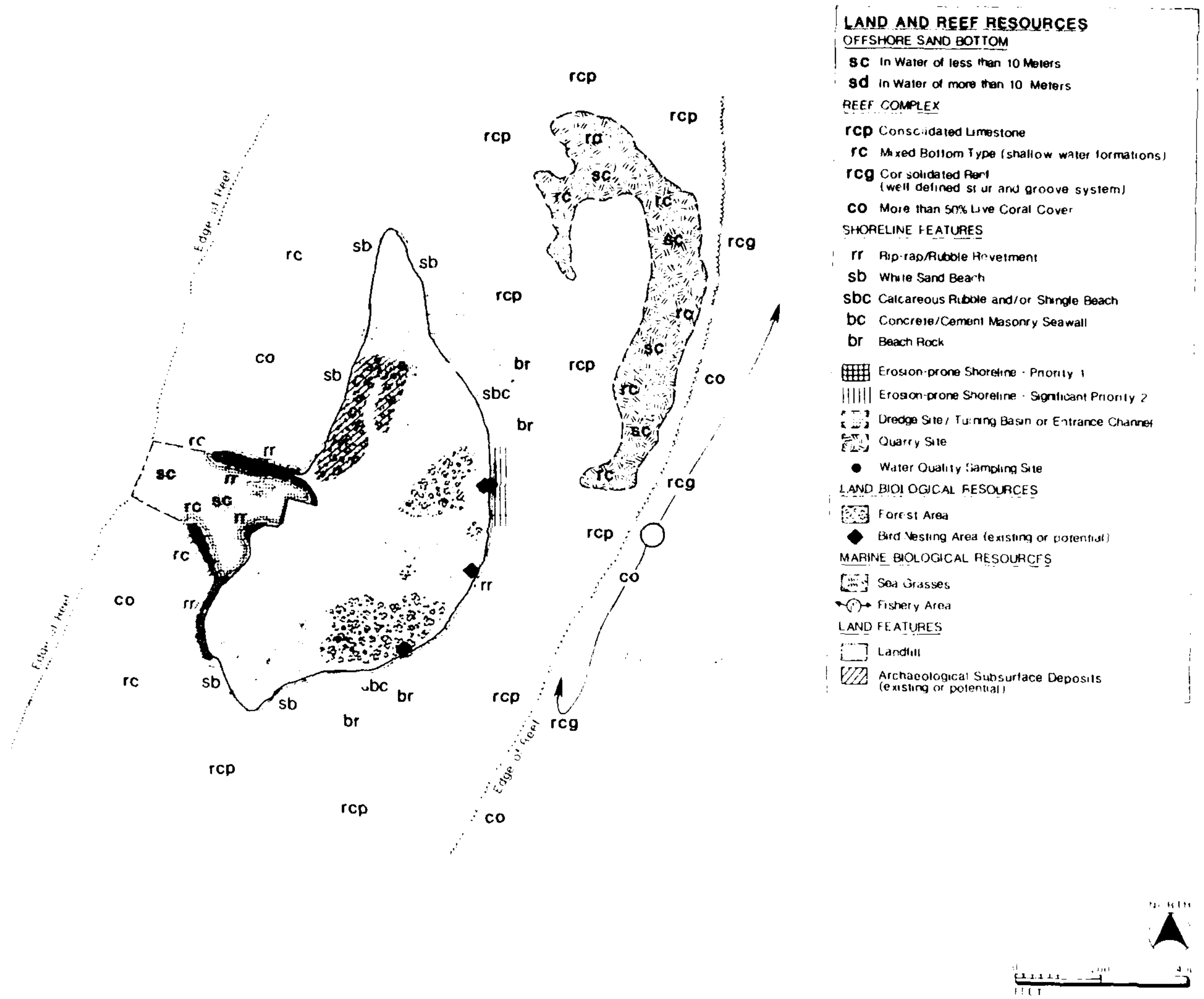
Figure 3.1-8



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES
GELLINAM ISLAND

Figure 3.1-9

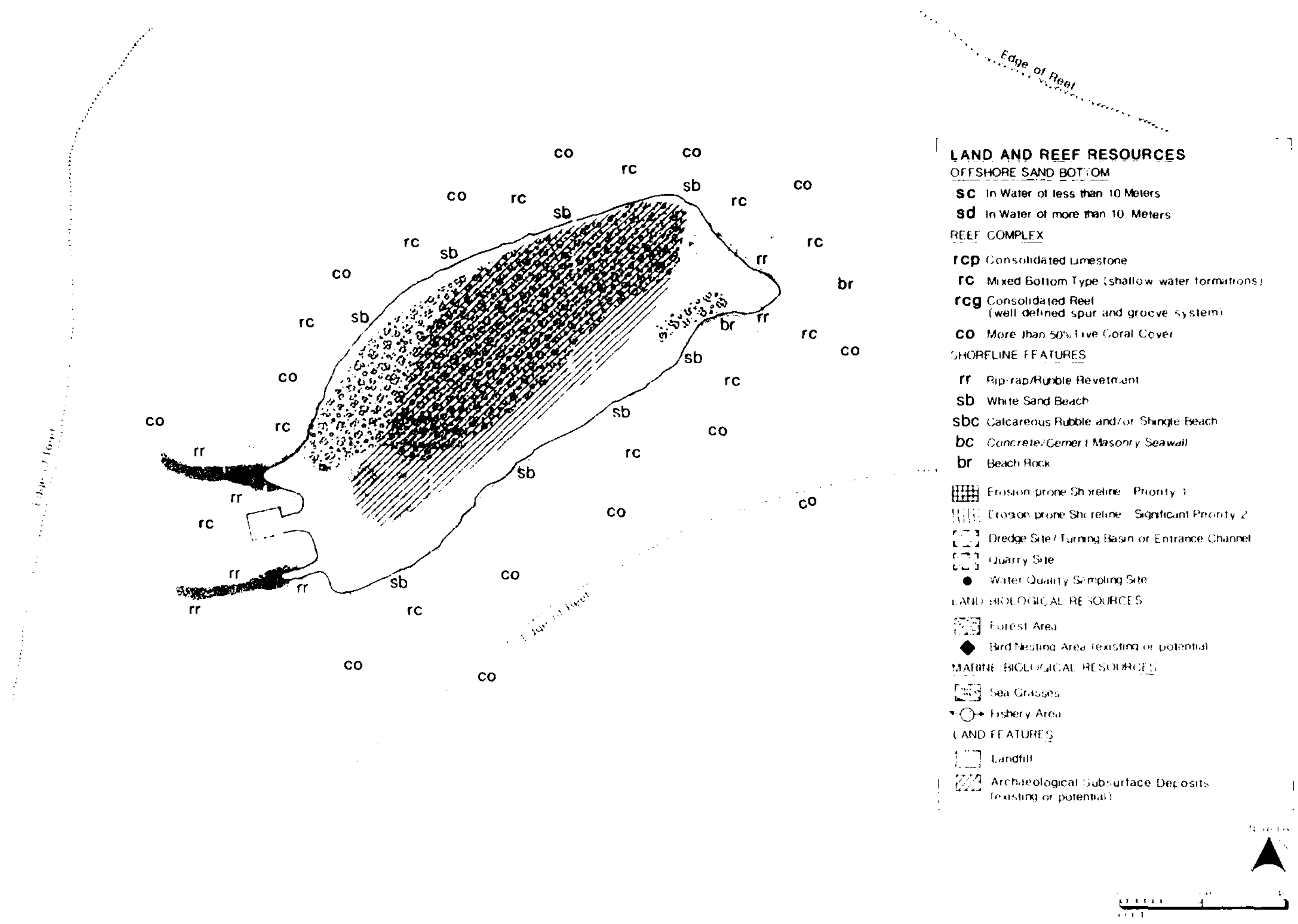


U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES

OMELEK ISLAND

Figure 3.1-10



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND AND REEF RESOURCES
ENIWETAK ISLAND

Figure 3.1-11

3.2 LAND AND REEF AREAS

Kwajalein Atoll is a crescent-shaped coral reef that encloses the world's largest lagoon, which has a surface area of 1,100 square miles. The atoll's longest dimension is 75 miles, from Kwajalein to Ebadon, and its greatest width is approximately 20 miles. The lagoon enclosed by the reef is generally between 20 and 30 fathoms deep (120 to 180 feet), although numerous coral heads approach or break the surface.

In contrast to the immensity of its water area, the land area of the atoll is only 5.6 square miles (3,584 acres). Although there are approximately 100 islands dotted along the coral reef margin of the atoll, the three largest islands (Kwajalein, Roi-Namur, and Ebadon), each located at the extremities of the atoll, account for nearly half the total land area (see Figure 1.1-3). The typical size of the remaining islands is a few acres, and the smaller islands are no more than ephemeral sand cays that just break the water's surface at high tide. All islands of the atoll are nearly flat, with few natural points that exceed 15 feet above mean sea level.

The 11 islands that make up the USAKA installation are located on the east and west reefs between the principal islands of Kwajalein and Roi-Namur (a distance of approximately 50 miles).

The following subsections briefly summarize relevant features of island and marine geology of the 11 USAKA islands.

3.2.1 ISLAND GEOLOGY

Island formation, soils, and shoreline erosion are described below. The region of influence for these resources includes the land and shorelines of the 11 USAKA islands.

3.2.1.1 Island Formation

The reefs and islands of RMI consist entirely of the remains of coral reef rock and sediments to a thickness of several thousand feet atop submarine volcanoes, which formed 70 to 80 million years ago. As the volcanoes became extinct and began to subside, living coral reefs grew upward to remain close to the sea's surface and formed atolls. Where growth was not maintained, the volcanoes sank well beneath the surface of the sea and formed seamounts and "drowned" atolls (guyots) (Darwin, 1898). Around Kwajalein Atoll the ocean depth is as much as 1,000 fathoms (6,000 feet) within 2 miles of the atoll, and 2,200 fathoms (13,200 feet) within 5 miles. The top of the Kwajalein Atoll reef (or reef flat) lies at intertidal level, mostly exposed at low tide and

submerged at high tide. Approximately 25 passages from the open ocean into the lagoon admit small boats. Oceangoing ships ordinarily use the deeper Gea Pass, 10 miles north-northwest of Kwajalein Island.

The reef rock is formed entirely from the remains of marine organisms (reef corals, coralline algae, mollusks, echinoderms, foraminiferans, and green sand-producing algae) that secrete external skeletons of calcium and magnesium carbonates. As these organisms grew and died, their remains were either cemented in place to form hard reef rock, or were eroded and carried down slopes to accumulate as sediment deposits, particularly in the lagoon or on deep terraces downslope on the ocean side of reefs. The reefs are growing actively as a result of vigorous development and populations of corals, coralline algae, and large mollusks. Only the upper thin veneer of the reef structure is alive and growing, accreting over the remains of prior generations of reef organisms. Although coral reefs are unique because they build and advance wave-resistant structures in the face of persistent and severe wave and storm attack, the organisms that form the reefs are vulnerable to sedimentation, burial, and changes in circulation caused by man's development activities.

The major reef-building organisms are all marine and cannot grow above average sea level because of the need for immersion. Land areas on reefs that project above high tide are formed by other processes. Large waves break loose corals, boulders, rubble, and sand from the reef flats, terraces, and slopes and throw them up on shallow flats to create storm ramparts and the beginnings of island masses. After many storms, a considerable amount of reef debris may be deposited with some cemented or consolidated in place via chemical processes to form beach rock, conglomerates, and breccias, which offer greater resistance to wave action and contribute to more stable islands. Other atoll islands may have been created when sea level was thought to be about 5 to 6 feet higher than it is today (about 4,000 years ago). Living reef would have grown up to the low-tide level of the time. As the sea level receded, reef areas were left above the current high-tide level to create islands. Both storm and higher sea level processes may have contributed to the formation of existing islands in Kwajalein Atoll.

3.2.1.2 Soils

The soils of Kwajalein Atoll, like most ocean atolls, have poor fertility and are particularly deficient in two major constituents, nitrogen and potash. The generally low fertility of the atoll soils is due to three factors: the soil particles are generally coarse, the content of organic

matter is low, and the soils are alkaline. The first two factors impair the water-holding capacity of the soil and the retention of elements essential for plant growth. The alkalinity of the soils inhibits the absorption of iron, manganese, zinc, boron, and aluminum. All three factors severely inhibit plant growth.

Of the six types of soils found on USAKA islands, only Arno loamy sand and Jemo series soil contain significant amounts of organic material. Kwajalein and Roi-Namur contain some Arno loamy sand, but the Jemo series soil is generally associated only with mature native forests and has been identified within USAKA only on Eniwetak and Legan Islands. These relatively more fertile soils are a valuable atoll resource and deserve consideration during development planning.

3.2.1.3 Shoreline Features

Shorelines of atoll islands are generally dynamic, eroding in one area and accreting in another. Development may significantly affect this process and important resources including man-made features can be damaged; therefore, these natural processes and their effects must be considered during development planning.

Most prevailing wave energy at Kwajalein Atoll is directed toward the north and east sides of reefs and islands and is generated by tradewind swells. Infrequent tropical storms and high latitude polar storms generate large swells and breaking waves that significantly affect the atoll. Tropical storm (including typhoon) waves generally approach from the southwest to southeast. Large waves that originate in the Arctic approach the atoll from the north, especially during the winter when Antarctic storm waves also approach from the south. These relatively long-period ocean swells have the potential to do considerable damage to Kwajalein Atoll because of high wave runup and overtopping of the land area. The nature of waves greatly influences the configuration and morphology of islands and reefs in Kwajalein Atoll.

The shorelines on the ocean sides of the islands are generally formed of coral rubble, gravel, and sand. The shorelines exposed to higher wave energy generally consist more of rubble and gravel, while those exposed to lower wave energy consist more of sand. The lagoon shorelines are generally sand. Carbonate beachrock, reef breccias, and conglomerate rock strata are exposed along some shorelines or are buried under loose sedimentary materials along other shorelines.

A field investigation of USAKA shorelines was conducted by oceanographic engineers in August 1987 (Sea Engineering and

R. M. Towill Corp., 1988). The shorelines of ten islands were inventoried to identify existing shoreline characteristics and conditions, including location, length, shoreline damage, nearshore facilities, overtopping, erosion vulnerability, and condition of coastal structures.

Table 3.2-1 and Figures 3.1-2 to 3.1-11 summarize the areas identified as priority one in the Sea Engineering report as well as those priority two areas considered most significant based on the severity of the risk, the potential for damage, and the proximity to existing or planned facilities. High-priority areas and other problem areas are improved with shoreline protection improvements such as revetments, rip-rap, and seawalls as an ongoing activity on the USAKA islands as funds permit. During 1988 and 1989, for example, shoreline protection work included 900 linear feet on Illeginni, 1,250 linear feet on Eniwetak, and 1,200 linear feet on Roi-Namur.

3.2.2 MARINE GEOLOGY

The following sections and Table 3.2-1 describe reef features, dredged and fill areas, and reef quarries of the USAKA islands, which form the region of influence for marine geology resources.

3.2.2.1 Reef Features

Activities of man and nature affect the reef structure, which may in turn affect other activities of man. For example, destruction of a productive fishing area may reduce fishing success. For this reason, reef features must be considered during development planning.

The geology of Kwajalein Atoll is typical of many atolls in Micronesia (Fosberg, et al., 1956); it includes a series of islands perched on a coral reef surrounding a lagoon. On the ocean side of an island there is generally a shallow reef flat of varying width that extends to a seaward slope. Ocean reef flats on the windward (north and east) side of the atoll are subjected to stronger wave action than leeward reef flats and are often characterized by a well-defined spur-and-groove system. Leeward ocean reef flats show this feature less commonly. The beaches on the ocean side are generally composed of gravel- to cobble-sized material. The lagoon reef is usually more narrow, ending in a lagoon terrace sloping to the lagoon floor. Beaches on the lagoon side are generally composed of finer material, usually sand. The windward ocean side reef flat generally has very hard rock that extends downward 2 to 4 feet from the surface, and softer or unconsolidated rock below that level. The lagoon reef has softer rock. Only the hard rock from the windward ocean side reef flats is suitable for use as armor stone for shore protection.

Table 3.2-1
CHARACTERISTIC FEATURES OF LAND AND REEF AREAS OF USAKA ISLANDS

Characteristic	Kwajalein	Roi-Namur	Meck	Ennylabegan	Legan	Illeginni	Gagan	Gellinam	Omelek	Eniwetak	Ennugarret
Area (acres)	748	398	55	124	18	31	6	5	8	15	24
Area of Fill Land (acres)	205	40	18	0	0	1	0	0	0	0	0
Significant shoreline vulnerability (percent of shoreline)[a]	19%[b]	35%[c]	0	0	0	25%	5%	0	14%	0	0
Shore Protection Features	Extensive shore protection, including revetments and seawalls	Some riprap revetments	Extensive riprap revetments	Little riprap revetments	One finger jetty	Riprap along harbor	Two rock jetties	Two revetted jetties	Two jetties	Two revetted jetties	0
Reef Features	Ocean reef flat with well-adjusted spur-and-groove system	Ocean reef flat on north and west sides with smooth, consolidated reef grading into spur-and-groove system; sand beaches on lagoon side	Ocean reef flat largely quarried except at northern end	Ocean reef flat lacks well-developed spur-and-groove system; most shoreline is sand beach	Ocean reef flat lacks well-developed spur-and-groove system	Narrow ocean reef flat lacks well-developed spur-and-groove system; lagoon reef much wider than other USAKA islands	Wide consolidated ocean reef flat with well-developed spur-and-groove; narrow belt with 50% coral coverage parallels shore on lagoon side	Wide consolidated ocean reef flat with well-developed spur-and-groove	Varying width ocean reef is consolidated, with well-developed spur-and-groove system; lagoon shoreline mostly sand beach	Located inside lagoon; no ocean reef; offshore band of coral with 50% coverage on east side	Ocean reef flat consolidated, with well-developed spur-and-groove
Dredged and Quarried Areas	Broad areas of inactive quarrying: south and northeast ocean flats. Quarrying since 12/87 on eastern reef flat. Most inactive quarries covered in fine sediment, indicating poor flushing. Former Japanese quarries on south side; more diverse coral reef biota. Lagoon side extensively dredged for fill and harbors.	Active and inactive quarries on ocean reef flat	Quarries date to 1964-74 period. Edges intentionally left irregular and support a more diverse biota than surrounding reef flat.	No quarries	Inactive quarry, irregular in shape, approx. 60' x 165'. Lagoon dredged adjacent to pier and launch ramp.	No quarries; harbor and channel dredged on lagoon side	Large inactive quarry on ocean side whose slope promotes good flushing; harbor area dredged	Large inactive quarry extends entire length of island on ocean side, with irregular bottom, varying topography, and coarse sediment on bottom.	Large inactive quarry on ocean reef flat and inter-island reef flat has good flushing with sediments no smaller than gravel; harbor area dredged	No quarries	No dredged or quarried areas
Sand Beaches	Some areas along lagoon	Along lagoon	Along lagoon	Most of ocean shoreline	Some of ocean shoreline; most along lagoon	Some of ocean shoreline	Most of ocean shoreline;	Most of ocean shoreline most of lagoon	Some along ocean shoreline	Along most lagoon	Most of lagoon

[a]Based on the classification in Sea Engineering and R. M. Towill Corp. (1988); priority one and priority two (high priority) areas judged most significant with moderate to high risk of overtopping and damage to facilities.
[b]Particularly significant in area adjacent to airfield.
[c]Particularly significant in area adjacent to ALTAIR radar.

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3.2.2.2 Dredged and Fill Areas

The islands of Kwajalein Atoll have often proven too small to accommodate the required USAKA facilities. Consequently, limestone materials have been dredged from the atoll reef flats and lagoon as fill for expanding the land area. Historically, Kwajalein Lagoon and reef flats have been dredged to obtain fill material and to create and maintain harbors near each island. This practice started at the time of the Japanese occupation. During 1988 to 1989, a number of harbors that had not been dredged in several years were dredged in a single multi-island dredging project. Quantities dredged in that project are shown in Table 3.2-2.

Table 3.2-2
DREDGING AT USAKA 1988 TO 1989

Island	Cubic Yards
Kwajalein[a]	4,140
Meck	6,570
Legan	1,630
Gellinam	2,110
Ennylabegan	8,930

[a]Barge bulkhead.

Source: Harbert International, Personal Communication, 1989.

More typically, harbors are dredged as the need arises; on average, each harbor is dredged about once a decade. For the routine USAKA dredging projects, a total of about 10,000 cubic yards per year is removed (for all harbors). Currently, there is a need for 16,000 y^3 of dredging. Of this, 6,000 y^3 are for maintenance at Kwajalein and Meck Island piers and 10,000 y^3 are for the enlargement of channels at Roi-Namur.

3.2.2.3 Quarries

Quarrying and dredging are the primary methods by which material is obtained for fill purposes and to use as aggregate for construction and shore protection. In addition, quarries provide virtually all large stone (armor rock) to protect shorelines and facilitate navigation. The need for armor rock and other aggregate for construction projects at USAKA has affected the nearshore reef flats as the source for such material. In the past, most quarrying has occurred on the ocean side of Kwajalein Island, but quarry holes have also been opened on the ocean side reef flats next to several other USAKA islands, as shown in Table 3.2-1.

Quarrying data for years prior to 1988 are not available. However, in 1988, approximately 62,500 y^3 of material was quarried at USAKA. Currently, 18,000 y^3 are stockpiled.

Needs for quarried material can be substantial. Revetments for protection against the 50-year design storm require 9.60 y^3 per linear foot of protected shoreline. Family housing construction (136 units completed in 1989) required approximately 22,500 y^3 of material. In all, an estimated 274,000 y^3 of aggregate would be required to fulfill priority repair needs on all USAKA islands.

Historically, quarry excavation has not been permitted to approach closer than 100 feet from the outer reef edge because of the recognized importance of the irregular spur-and-groove pattern of the reef edge on the ocean side. That margin should not be damaged because it provides natural protection from large waves. The quarry setback also provides 100 feet of reef limestone that serves as a buffer between the waves and the quarry hole, and is considered adequate to provide protection against very long-term retreat of the reef caused by solution actions or by the occurrence of extreme wave conditions.

The inactive quarries at USAKA vary considerably in age and form. The ocean reef flats on the southern side of Kwajalein Island contain a series of quarries of irregular shape known as the "Japanese pools," that date to the occupation of the islands before World War II. They show a somewhat more diverse biota than the more regularly shaped quarries dredged between 1959 and 1970 and the more recent quarrying that began in late 1987.

A beneficial effect of quarrying is the creation of new habitat within the quarry holes compared with the sparsely populated reef flat. However, the shape and depth of the quarries appear to affect the diversity and abundance of biota within the quarry. Evidence from the range of quarry shapes and types at Kwajalein suggests that those with more irregular shapes and depths that are oriented toward currents and waves to provide better drainage offer a more diverse and productive environment than more regular, deeper, and poorly drained quarries, which tend to accumulate fine sediment.

This generalization seems to be borne out in the inactive quarries of Meck Island. These quarries were created from 1964 to 1974 and were designed as a series of cells parallel to the shoreline rather than as a single large cell. Although their shape is generally rectangular, their edges were intentionally left irregular to create a more complicated, heterogenous environment. Relief within the quarries varies because armor stone blocks remain in some of the quarries. The overall result is a habitat and biota richer and more diverse than that of the surrounding reef flat.

3.3 WATER RESOURCES

3.3.1 FRESHWATER

Rainfall

The primary source of freshwater at USAKA is rainfall, which is usually abundant. Rainfall is collected directly in catchments or, after percolation through the soil, is pumped from the groundwater for freshwater use. The principal rainfall season extends from May through November. The December through April period, often referred to as the "dry season," is characterized by light showers of short duration. Kwajalein had an unusually severe dry season in 1983 (19 weeks passed with no appreciable rainfall) and 1984 was the driest year on record. Normal and extreme precipitation for Kwajalein are shown in Table 3.3-1.

Table 3.3-1
NORMAL AND EXTREME PRECIPITATION BY MONTH[a]
(inches)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Normal precipitation	4.91	2.97	5.17	7.6	11.24	10.11	10.30	10.30	10.94	12.24	10.97	7.96	104.7
Maximum monthly precipitation	15.66	9.05	24.33	20.29	26.86	19.61	17.33	17.46	21.16	20.05	19.51	30.38	--
Year	1951	1976	1951	1971	1980	1955	1958	1979	1972	1964	1957	1950	--
Minimum monthly precipitation	0.48	0.04	0.16	0.20	0.53	3.56	3.53	5.38	5.32	5.04	3.51	1.90	--
Year	1977	1977	1975	1983	1984	1984	1984	1981	1965	1969	1973	1971	--

[a]National Oceanic and Atmospheric Administration. 1985 Local Climatological Data, Annual Summary, Kwajalein Marshall Islands.

The variable nature of rainfall is evident upon examination of the extremes for precipitation. Minimum monthly precipitation of 0.04 inch in February 1977 and maximum monthly precipitation of 30.38 inches in December 1950 are on record. Normal annual precipitation is 104.71 inches.

Groundwater

Groundwater is a major source of potable water on Kwajalein and Roi-Namur Islands, along with rainwater catchment. Therefore, preservation of groundwater quantity and quality is important to ensure a continued supply of drinking water. The following subsections describe the existing groundwater supply and quality on Kwajalein and Roi-Namur Islands, primarily drawing on information from a 1980 groundwater resource evaluation (Hunt and Peterson, 1980). The potable water treatment and distribution system is discussed in Section 3.12, Utilities (Subsection 3.12.1, Water Supply).

Fresh surface water bodies such as lakes are rare in the Marshall Islands, and the flat landscape, permeability of rock structure, and composition of soils and reef-derived sediments prevent the occurrence of streams. Many islands have central depressions with small brackish water ponds.

Fresh groundwater on the atolls consists of a lens of freshwater that floats atop deeper marine waters in the subsurface rock strata of larger and wider islands. Rainwater percolates down through the surface to collect in the lens and the consistency and permeability of the rock strata maintains the integrity of the lens, slowing the mixing of the freshwater lens with surrounding marine water. The thickness of the lens system for a particular island depends on many factors, but they tend to be of greater thickness for larger islands.

The distribution of impermeable rock, tidal fluctuations, and gravitational forces influence the mixing rates of the fresh groundwater with surrounding marine waters and, therefore, influence the size and salinity of the lens. Salt spray from wind and breaking waves and mineral dissolution also increase the salinity of groundwater lenses.

Currently, freshwater use usually exceeds rainfall collected in catchments and, in order not to deplete the supply of stored water from which day-to-day needs are met, additional water is obtained from the groundwater lens well system. A study to evaluate the long-term sustainable yield of the Kwajalein groundwater found that the freshwater storage in the lens averaged about 270 million gallons, and that it fluctuates more than 20 percent in response to recharge and discharge events (Hunt and Peterson, 1980). Recharge to the fresh groundwater lens during the 12-month study period was estimated to be 236 million gallons, or 52 percent of the annual precipitation. The relative distribution of recharge was found to be quite uneven, with some areas adjacent to paved surfaces receiving recharge at rates as much as four times greater than other areas. There are insufficient data to determine an accurate measure of sustainable yield for the Kwajalein groundwater body. Findings suggest that a sustainable yield is greater than the 33 million gallons per year withdrawn during the 1978 to 1979 year, and rough estimates indicate that it may exceed 50 million gallons per year.

Water quality is a constant concern because of the uncertainty of rainwater supply and the limited amount of freshwater in the groundwater lens. Water supply may become a critical concern during a year when rainfall is less than normal. Groundwater data are insufficient. Plans are being made to conduct a groundwater sampling program in the summer of 1989.

During the study to evaluate the long-term sustainable yield of the Kwajalein groundwater, 23 observation wells were constructed. The thickness, areal extent, and water quality (chloride concentration) of the Kwajalein groundwater lens were monitored. The only water quality parameter monitored during the study was chloride concentration. The extent of the 250-mg/L isochlor level on the dates of the maximum and minimum groundwater inventory was identified. The 250-mg/L chloride level is at the upper range of values considered acceptable for drinking water. Chloride values for groundwater used on Kwajalein and Roi-Namur are consistently well below this value. Information on quality of the freshwater supply system is described in Subsection 3.12.1.

The presence of hydrocarbons (e.g., diesel fuel) was reportedly observed in a foundation excavation for a construction project located in the vicinity of the Power Plant 1 fuel tank farm (personal communication, Randy Gallien, 1989).

Surface Water

For sources of freshwater, Kwajalein uses water from 52 acres of paved catchment areas that are located adjacent to the runway and from several groundwater lens wells. The catchment areas collect approximately 1 million gallons per inch of rainfall. The average capture of rainwater is 8.8 million gallons per month assuming 100 percent yield of water from the catchment areas for an average month. An abnormally low rainfall period occurred during 1984 and 1985. During this period, only 2.8 million gallons per month was captured, an amount that reflects less than one-third of daily demand.

Roi-Namur uses two catchments similar to those on Kwajalein, each with a 750,000-gallon volume. Meck and Ennylabegan each use catchments to collect water for their potable water systems.

3.3.2 MARINE WATER QUALITY

Marine water quality around USAKA islands has generally been satisfactory except in the immediate vicinity of a few point and nonpoint sources (U.S. Army BMDSCOM, 1980; Aecos, 1988; Titgen, et al., 1988; Sea Engineering, 1989). These sources include sewage, suspended sediment, heated water, storm drain runoff, sandblasting material (associated with corrosion prevention), construction debris, and landfill leachate. Water quality generally remains satisfactory because tidal, tradewind, and wave-generated offshore currents dilute and carry away pollutants.

For purposes of the analysis in this DEIS, standards are based on two previously issued National Pollutant Discharge

Elimination System (NPDES) permits issued by the U.S. Environmental protection Agency for point source dischargers for the USAKA islands of Kwajalein, Roi-Namur, Meck, and Ennylabegan. The first permit (NPDES Permit No. TT0110035) sets effluent quality requirements for domestic sewage dischargers. These effluent requirements essentially require secondary treatment of the sewage. The second discharge permit (NPDES Permit No. TT0110027) sets effluent quality requirements for industrial dischargers that include once-through cooling water discharges.

The only USAKA islands with identified problems are Kwajalein and Roi-Namur. Summary data are presented under the subheading "Sampling and Analysis."

General Oceanic Conditions

The waters around Kwajalein Atoll are well mixed and are not affected by large nearby land masses and continents. The Pacific Ocean is deep and its waters are pollution-free, pristine, and extremely transparent around Kwajalein and other atolls in the Marshall Islands.

The prevailing tradewinds generate swells in open seas that break along the upper ocean slopes of reefs facing north to east in the Marshall Islands. This wave action drives water over the reef ridge where it runs "downhill" across the reef into the lagoon or passes. These wave-driven currents are particularly strong at high tide, can achieve speeds of 2 to 4 knots, and are generally unidirectional on windward reefs (toward the lagoon) regardless of the state of the tide. These currents are a major source of ocean water exchanging with lagoon waters and help to keep lagoons relatively well mixed. Where wave-driven water currents push over reefs and against island shorelines (wave setup), water levels can be elevated 2 feet or more above ambient sea level. As water seeks the path of least resistance in running downhill into the lagoon, very strong currents can be generated, especially along shore and through restricted openings between adjacent islands on the reef flat.

Kwajalein Atoll's lagoon is considered to be open, with several major passes and extensive exposure to wave-generated water currents constantly pouring into the lagoon from the windward side (see Figure 1.1-3). Surface currents inside the lagoon typically head southwestward at a rate of 2 to 3 knots and do not reverse with the tide change (Defense Mapping Agency, 1976).

Water circulation in the Marshall Islands was described by von Arx (1954) and Atkinson (1987). As a result of solar insulation, lagoon waters tend to be slightly warmer than oceanic waters. Water currents driven over the windward reef flats by wave action heat up somewhat before reaching

the lagoon side, but are normally cooler than lagoon waters. These cooler waters descend to the bottom of the lagoon because of greater specific gravity and spread out, slowly mixing with shallower lagoon layers. Dissolved oxygen levels in the lagoon are, therefore, high and typical of oceanic conditions, as are pH levels. Salinity levels are essentially the same for both lagoon and ocean waters. Temporary minor depression of lagoon surface water salinities occurs after heavy rainstorms due to dilution by cooler rainwaters. Because of slightly higher natural levels of plankton and suspended sediments in lagoon waters, turbidity tends to be slightly higher compared with ocean levels.

Thermal Discharges

Marine surface water temperatures at Kwajalein Atoll generally range from 27.5°C to 31°C. USAKA power plants and radars use seawater as a heat exchange medium (i.e., cooling water) resulting in the discharge of heated effluents. Water temperature near the power generating station discharge at Roi-Namur averaged 33.8°C during the 1988 sample period (Aecos, 1988). A 1975 survey identified 11 thermal outfalls on Meck, Roi-Namur, and Kwajalein Islands (McCain and Maragos, 1975). Survey conclusions were that these outfalls did not appear to cause significant impacts to the marine environment because most of the discharge plumes were small or did not impinge upon the bottom environment near viable coral reef areas. In addition, temperature buildup is prevented because water discharged over the reef flat exchanges with each tidal cycle. Currently, only four primary thermal discharges exist, two on Kwajalein and two on Roi-Namur. An additional discharge will exist when Power Plant 1A is completed in mid-1989.

The combined thermal effluent from existing Kwajalein Power Plants 1 and 2 is 5,040 gallons per minute. The effluent temperature is no greater than 10°F (5.6°C) above ambient water temperature. The thermal effluent from the Roi-Namur power plant is 2,820 gallons per minute with a rise in temperature of up to 10°F (5.6°C). Warm water discharge near the Yokohama Pier appeared to be contributing to a white fuzz covering the rocks (Titgen, et al., 1988).

Stormwater Runoff

The magnitude of silt produced by natural erosion at USAKA has not been established. It is probably far less than the amount produced by intermittent dredging, and its impact is largely confined to the nearshore area.

Natural runoff levels have probably increased over the years because of increases in paved areas and compaction of soil. Nevertheless, stormwater runoff has not noticeably adversely affected the marine environment. Unpaved and uncompacted

ground surfaces are very porous and intercept much of the runoff from paved surfaces.

Dredging and Quarrying

Periodic dredging for harbor maintenance and fill material (described in Subsection 3.2.2.2) and quarrying (Subsection 3.2.2.3) produce and suspend silt and fine sediments that can be transported from the dredging site by currents to adjacent coral-rich areas. Under certain conditions, sediment can depress coral growth by inhibiting light penetration and by direct smothering. Turbidity during dredging is not currently monitored at USAKA.

Coral habitats that are sensitive to suspended sediment are identified in the marine biological section and are located downcurrent of harbor and channel areas off Kwajalein, Illeginni, Gagan, Gellinam, Omelek, and Enewetak Islands.

Solid and Hazardous Waste

Heavy metal concentrations in seawater off the Kwajalein and Roi-Namur dump complexes (Sites 2 and 6 in Aecos, Inc., 1988; USAEHA, 1977) showed levels exceeding EPA receiving water quality criteria for copper and lead and exceeding Trust Territory receiving water quality standards for copper and zinc (Table 3.3-2). Analyses also indicated elevated nutrients and coliform (Tables 3.3-3 and 3.3-4). Petroleum was also detectable as a visible film at the same site (Aecos, 1988). Furthermore, tissue levels of copper in crabs taken off the Kwajalein dump were found to be many times higher than at other locations (Table 3.3-5). Collectively, these effects at the coastal site adjacent to the dump complex indicate significant (if localized) impacts of solid and hazardous waste practices on marine water quality.

Sewage Discharge

Discharge of sewage on Kwajalein occurs following treatment in the secondary treatment plant. Approximately 465,000 gpd are discharged with an average BOD of 5 mg/L and 20 mg/L of suspended solids. Discharge Permit No. TT0110035 allowed a discharge up to 600,000 gpd with 30 mg/L BOD and 30 mg/L suspended solids. Discharge of sewage effluents off Kwajalein Island is not currently causing significant water quality impacts. Water quality analyses and ecological observations at the discharge site (Aecos, Inc., 1988; Titgen, et al., 1988) do not indicate significant water quality degradation or observable adverse impacts on the nearest coral reef life and fishes.

The sewage system for Roi-Namur consists of an ocean outfall and septic tank/leach field(s). The ocean outfall presently discharges about 43,000 gpd of raw wastewater. The BOD is

Table 3.3-2
SUMMARY OF WATER QUALITY DATA ON HEAVY METALS COLLECTED FROM KWAJALEIN ISLAND (SITES 1-5) AND ROI-NAMUR ISLAND (SITES 6-10) BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988

	Lead (mg/L)	Zinc (mg/L)	Copper (mg/L)	Mercury (mg/L)
Standards				
EPA[a] Chronic	0.0056	0.086	0.0029	0.000025
Acute	0.140	0.095	0.0029	0.0021
TTPI[b]	0.01	0.00002	0.01	0.0001
Site 1	<0.005	<0.050	<0.001	<0.0005
Site 2	0.047	0.053	0.066	<0.0005
Site 2 dup.			0.055	<0.0005
Site 3	0.031	<0.050	0.018	<0.0005
Site 4	0.006	<0.050	<0.001	<0.0005
Site 5	0.016	<0.050	<0.001	<0.0005
Site 6	<0.005	<0.050	<0.001	<0.0005
Site 7	<0.005	<0.050	<0.001	<0.0005
Site 8	<0.008	<0.050	<0.001	<0.0005
Site 9	0.006	<0.050	<0.001	<0.0005
Site 10	<0.005	<0.050	<0.001	<0.0005
Field blank (2)	<0.005	<0.050	<0.001	<0.0005

Source: Aecos, Inc., 1988.

[a] EPA Marine Water Quality Criteria, 1987.
[b] TTPI = Trust Territory of the Pacific Islands, Environmental Protection Board Rules and Regulations, Public Law 4C-78 (63 TTC 501 et seq.).

Note: Water quality sampling site locations are indicated in Figures 3.1-2 and 3.1-3.

Table 3.3-3
SUMMARY OF WATER QUALITY DATA COLLECTED FROM
KWAJALEIN ISLAND (SITES 1-5) AND ROI-NAMUR ISLAND (SITES 6-10)
BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988: NUTRIENTS

	Nitrate (mg N/L)	Nitrite (mg N/L)	Ammonia (mg N/L)	Total Nitrogen (mg N/L)	Total Phosphorus (mg P/L)
Trust Territory Standards[a]				0.400	0.025
Sample Values[b]					
Site 1	0.002	<0.002	0.003	0.147	0.014
Site 2	0.030	0.001	0.029	0.201	0.070
Site 3	0.010	<0.001	0.030	0.210	0.038
Site 4	0.022	0.001	0.005	0.141	0.009
Site 5 (control)	0.002	0.001	0.004	0.132	0.003
Site 6	0.021	0.002	0.019	0.252	0.028
Site 7	<0.001	0.001	0.001	0.153	0.012
Site 8	0.007	0.002	0.003	0.163	0.010
Site 9	0.009	0.002	0.014	0.204	0.062
Site 10	0.006	<0.001	0.006	0.217	0.006

Sources:
[a] Trust Territory of the Pacific Islands, Environmental Protection Board Rules and Regulations, Public Law 4C-78 (63 TTC 501, et seq.) effective May 30, 1980. Title G3, Chapter 13, Subchapter VII.
[b] Aecos, Inc., 1988.

Note: Water quality sampling site locations are indicated in Figures 3.1-2 and 3.1-3.

Table 3.3-4
SUMMARY OF WATER QUALITY DATA COLLECTED AT
KWAJALEIN ISLAND (SITES 1-5) AND ROI-NAMUR ISLAND (SITES 6-10)
BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988:
WATER QUALITY PARAMETERS AND COLIFORMS

	Salinity (ppt)	Salinity (ppt)	Total Coliform (# col/ 100 mls)	Turbidity (ntu)	Turbidity (ntu)	pH
Site 1	34.1	--	<1	0.72	0.52	8.30
Site 2	18.5	32.13	26	29.8	1.50	8.27
Site 3	25.3	--	40	28.1	1.61	8.28
Site 4	34.5	--	<1	--	0.32	8.26
Site 5	34.3	33.43	<1	--	0.32	8.33
Site 6	--	32.95	18	1.10	1.14	8.19
Site 7	--	32.68	<1	0.38	0.69	8.20
Site 8	35.2	32.85	<1	0.60	0.66	8.20
Site 9	--	32.75	<1	0.69	1.08	8.15
Site 10	34.8	--	1	0.35	0.49	8.18

Source: Aecos, Inc., 1988.

Note: Water quality sampling site locations are indicated in Figures 3.1-2 and 3.1-3.

Table 3.3-5
CONCENTRATIONS OF METALS DETECTED IN MARINE BIOTA AND WATER OF KWAJALEIN ATOLL
JULY TO AUGUST 1976

Site	Sample	Metals[a] Cadmium	Copper	Mercury	Lead	Zinc	Arsenic
Kwajalein Dump	Fish	b	0.65	0.09	0.16	2.48	0.65
	Snails	0.99	4.27	0.08	1.52	16.71	1.14
	Crabs	0.11	58.60	b	2.11	4.52	0.84
	Coral	0.04	0.41	0.04	2.02	3.41	3.00
	Water	b	0.043	b	b	0.056	c
Kwajalein Lagoon	Fish	b	0.41	0.09	.15	b	0.32
	Crabs	b	40.54	b	0.09	4.68	0.16
	Coral	0.04	3.23	b	0.39	0.22	0.80
	Water	b	b	b	b	0.015	c
Kwajalein Harbor	Fish	b	0.34	0.16	0.10	1.64	0.23
	Snails	0.23	4.76	0.09	1.10	22.59	0.15
	Sponge	0.17	6.43	b	0.72	1.70	0.11
	Barnacles	0.24	4.08	0.08	0.33	16.21	0.33
	Water	b	b	b	b	b	c
Kwajalein Japanese Pools	Fish	b	0.86	b	0.37	2.47	0.57
	Snails	0.12	5.44	0.06	0.40	24.60	0.17
	Crabs	b	15.99	0.05	0.14	4.46	0.37
	Coral	0.10	3.35	b	1.68	0.24	1.09
	Sea cucumber	b	0.21	0.10	0.18	0.62	0.31
	Water	b	b	b	b	b	c
Biggerman Island	Fish (herbivore)	b	0.45	0.05	b	b	0.77
	Fish (carnivore)	0.10	0.78	0.06	0.17	19.58	0.24
	Snails	1.71	8.14	0.09	1.06	12.81	1.14
	Clams	0.59	0.87	b	b	15.32	2.54
	Crabs	2.16	18.75	b	0.23	6.95	0.23
	Coral	b	0.31	b	0.45	0.52	0.50
	Lobster	6.41	7.27	0.14	0.24	3.68	0.17
	Sponge	0.17	0.90	0.07	0.17	1.05	0.39
	Water	b	b	0.0006	b	b	c
Roi-Namur Ocean Side	Snails	0.14	5.46	b	0.17	8.96	0.44
	Coral	b	2.13	0.03	0.56	0.23	0.64
	Sponge	b	0.65	b	0.29	0.38	0.18
	Sea cucumber	b	0.56	0.04	1.06	0.51	0.19
	Water	b	0.037	b	b	b	c
Roi-Namur Dump	Fish	b	1.54	0.19	b	b	0.32
	Snails	0.57	5.95	0.04	0.76	17.23	0.30
	Clams	0.38	0.38	b	0.85	15.79	1.45
	Coral	0.14	3.50	b	1.64	3.62	0.68
	Sponge	0.09	0.27	b	0.14	0.98	0.16
	Sea cucumber	b	0.32	b	0.40	0.44	0.54
	Water	b	0.038	0.0003	b	b	c
Meck Island	Fish	b	0.44	0.07	b	0.62	0.36
	Snails	1.35	2.53	0.08	0.55	12.64	0.21
	Crabs	0.16	14.05	0.20	0.16	1.77	0.29
	Coral	0.10	1.96	b	1.12	3.24	0.49
	Water	b	b	b	b	b	c
Illeginni Island	Snails	0.19	3.35	0.06	0.57	5.62	0.46
	Crabs	b	48.43	0.04	b	4.01	0.63
	Water	b	b	b	b	b	c
Lowest detectable limit--water		0.005	0.025	0.0002	0.005	0.015	c
Lowest detectable limit--tissue		0.01	0.025	0.01	0.05	0.05	0.05
TTPI water standard[d]		5 µg/l	0.01 mg/l	0.0001 mg/l	0.01 mg/l	0.00002 mg/l	0.01 mg/l

[a]Tissue levels expressed in mg/kg; water levels expressed as mg/l.
[b]Not detectable.
[c]Analysis not performed.
[d]Source: TTPI EPB Rules and Regulations, PL 4C-78, (63TTC 501 et seq.).

Source: U.S. Army Environmental Hygiene Agency, 1977.

approximately 216 mg/L and suspended solids were reported to be "about half of what is normally found in raw domestic wastewater" (Sea Engineering, 1989). The ocean outfall for Roi-Namur is covered in the discharge permit mentioned above for Kwajalein with the same standards applicable, except flow at Roi-Namur, which can be up to 65,000 gpd. Marine ecological observations in the vicinity of the outfall (Titgen, et al., 1988) did not reveal any ecological effects of the discharge, but raw sewage effluent is a potential public health risk and an aesthetic impact.

Ocean Dumping

In the past, USAKA dumped bulky metallic and other related waste pursuant to a permit issued by the United States Environmental Protection Agency under the Marine Protection, Research and Sanctuaries Act (MPRSA), as amended, 33 U.S.C. 1401 et seq. A designated site 2.1 miles west of Kwajalein Atoll South Pass within a 1,000-yard radius of 08 degree 46' north latitude, 167 degrees east longitude, and at a depth of 1,655 fathoms, was used for such disposal. The ocean dumping permit has expired and no new permits have been executed. Ocean dumping operations do not currently occur at USAKA.

Sampling and Analysis

A 1976 study (USAEHA, 1977) lists concentrations of various metals in the biota and water column around several Kwajalein Atoll locations. No standards exist for metal concentrations in tissue; however, tissue levels of copper in crabs taken off Kwajalein landfill and in the lagoon were much higher than at other locations (Table 3.3-5). Copper and mercury levels in the water column reported in the 1976 study exceeded the Trust Territory ambient water quality standards in effect at the time near the sanitary land fill on Kwajalein Island and the open dump on Roi-Namur (Table 3.3-5).

Water quality measurements were taken in situ and samples were collected at five locations each on Kwajalein (Sites 1 to 5) and Roi-Namur (Sites 6 to 10) Islands for later analysis in Honolulu by Aecos, Inc., (1988) (see Figures 3.1-2 and 3.1-3). Tables 3.3-2 through 3.3-4 and Tables 3.3-6 through 3.3-9 contain summary data that reflect these analyses, including nutrients, specific heavy metals, pesticides, PCBs, and oil and grease. In addition, pH, dissolved oxygen, salinity, turbidity, and temperature were measured in the field.

The water samples collected and analyzed suggested that only one area, the shallow reef flat off the southwest shore of Kwajalein Island (Sites 2 and 3), had specific pollution problems. Contamination of the water by heavy metals

Table 3.3-6
SUMMARY OF WATER QUALITY DATA COLLECTED AT
KWAJALEIN ISLAND (SITES 1-5) AND ROI-NAMUR ISLAND (SITES 6-10)
BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988: CHLORINATED ORGANICS

		Pesticide Residues			
	Chlordane (ppb)	P,P'DDD (ppb)	P,P'DDT (ppb)	P,P'DDE (ppb)	PCB 1016 (ppb)
Sites 1 to 5	<0.6	<0.2	<0.2	<0.2	<0.9
Sites 6 to 10	<0.6	<0.2	<0.2	<0.2	<0.9

Source: Aecos, Inc., 1988.

Note: Water quality sampling site locations are indicated in Figures 3.1-2 and 3.1-3.

Table 3.3-7
SUMMARY OF WATER QUALITY DATA COLLECTED AT
KWAJALEIN ISLAND (SITES 1-5) AND ROI-NAMUR ISLAND (SITES 6-10)
BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988: CHLORINATED ORGANICS

	PCB 1221 (ppb)	PCB 1232 (ppb)	PCB 1242 (ppb)	PCB 1248 (ppb)	PCB 1254 (ppb)	PCB 1260 (ppb)
Sites 1 to 5	<1.7	<1.7	<1.2	<0.9	<1.2	<1.2
Sites 6 to 10	<1.7	<1.7	<1.2	<0.9	<1.2	<1.2

Source: Aecos, Inc., 1988.

Note: Water quality sampling site locations are indicated in Figures 3.1-2 and 3.1-3.

Table 3.3-8
WATER QUALITY RESULTS OF OIL AND GREASE SAMPLES
COLLECTED FROM FOUR STATIONS ON KWAJALEIN ISLAND
BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988

	Oil & Grease (mg/L)
Station 0 (control)	3.0
Station 1	3.7
Station 2	3.4
Station 3	<3.0

Source: Aecos, Inc., 1988.

Table 3.3-9
SUMMARY OF WATER QUALITY DATA COLLECTED FROM
KWAJALEIN ISLAND (SITES 1-5) AND ROI-NAMUR ISLAND (SITES 6-10)
BETWEEN 28 SEPTEMBER AND 12 OCTOBER 1988: HEAVY METALS

	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)
TTPI Standards[a]	0.01	0.005	0.050
Site 1	0.001	<0.001	<0.005
Site 2	0.001	0.002	<0.005
Site 3	0.001	0.001	<0.005
Site 4	<0.001	<0.001	<0.005
Site 5	0.001	<0.001	<0.005
Site 6	0.001	0.001	<0.005
Site 7	0.001	0.001	<0.005
Site 8	0.001	<0.001	<0.005
Site 9	0.001	<0.001	<0.005
Site 10	0.001	<0.001	<0.005
Field blank	<0.001	<0.001	<0.005

[a]Trust Territory Environmental Protection Board Rules and Regulations, Public Law 4C-78 (63 TTC 501 et seq.).

Source: Aecos, Inc., 1988.

Note: Water quality sampling site locations are indicated in Figures 3.1-2 and 3.1-3.

(particularly copper, lead, and zinc (Table 3.3-2) and, to a lesser extent, by nutrients and coliform bacteria (Tables 3.3-3 and 3.3-4), was detected. Contamination by ash, contributing to high turbidity and suspended solids, was also recorded. One suspected source of the contamination is the erosion of burned refuse at the high tide shore. Whether it is this ash that is the source of the heavy metals or the scrap material dumped along the shore cannot be determined from the study. Most of the scrap metal is iron and steel; however, copper pipe, brass fittings, and lead storage batteries were also present. The present refuse dump on Kwajalein appears to be the source of the non-metals contamination observed and/or measured, and may well be the source of the heavy metals detected in adjacent waters. Current waste management practices are discussed in more detail in Section 3.12, Utilities (Subsection 3.12.3, Solid Waste).

A similar contamination of nearshore waters was not detected at Roi-Namur where scrap metal covers a portion of the shore. Although the Roi-Namur refuse dump is situated similarly to the Kwajalein refuse dump, it is smaller and waves did not wash burned refuse onto the reef at Roi at the time of the survey.

3.3.2.1 Kwajalein Island

Water quality in the immediate vicinity of Kwajalein Island is generally of the same pristine condition as the surrounding ocean and lagoon waters. Specific water quality conditions at Kwajalein Island are described here. Waters in the vicinity of the Kwajalein landfill and burn pit (Sites 2 and 3) registered nitrates, ammonia, total nitrogen, and total phosphorus well elevated above oceanic values (Table 3.3-3). Coliforms were present in the water at an estimated concentration of 26 to 40 individuals per 100 milliliters (Table 3.3-4). Turbidity ranged between 1 and 30 nephelometer turbidity units (ntu), and was observed (but not measured) to be much higher at high tide. Detectable amounts of arsenic, cadmium, copper, lead, and zinc were measured (Tables 3.3-2 and 3.3-9). As noted previously, the source of these heavy metal contaminants may be ash from the refuse burn pits or scrap material dumped at the shore (Aecos, 1988).

3.3.2.2 Roi-Namur Island

The waters off Roi-Namur are of generally excellent quality, with specific exceptions. At the present time, raw sewage (1,000 gallons every 30 to 45 minutes) is discharged directly into the lagoon. The refuse dump for Roi-Namur is located on fill land near the southwestern tip of the island. Nutrient concentrations in the water samples near the refuse dump (Site 6) were elevated compared to pristine ocean water

and higher than at all other sites sampled except for the sites off the Kwajalein Island refuse dump. Average total nitrogen concentration was higher at this site as well. Coliforms were also detected. Chlordane, DDT derivatives, PCBs, and heavy metals were either not detected or occurred at very low background levels (Tables 3.3-5 to 3.3-7). None of the water quality parameters measured off the fuel pier (Site 7) was unusual or indicative of specific water quality problems, nor were the measurements near the power generating station (Site 8) with the exception of temperature and possibly lead. The two samples for lead did not replicate; one indicated a concentration below the level of detection (level of detection = 0.005 mg/L Pb), the other gave a value of 0.008 mg/L. The average value of lead in seawater is approximately 0.000002 mg/L. The EPA criteria for lead in seawater are 0.140 mg/L (acute) and 0.0056 mg/L (chronic). Thus, the 0.008 mg/L result represents a potential concern because it is slightly greater than the chronic criterion; however, the value is only slightly greater than the level of detection. Nitrates were very slightly elevated. Coliforms, chlordane, DDT derivatives, PCBs, and heavy metals were not detected.

Nitrate and ammonia were slightly elevated, and total phosphorus clearly elevated in the somewhat confined waters of the Roi-Namur marina (Site 9) (Table 3.3-3). None of the other water quality parameters measured at this site was unusual or indicative of specific water quality problems.

3.4 AIR QUALITY AND NOISE

3.4.1 AIR QUALITY

Air quality at Kwajalein may be significantly affected by ongoing and proposed activities, including electricity generation, transportation, and missile launches. For the purposes of this analysis, the region of influence for air quality includes areas in Kwajalein Atoll where people, vegetation, fauna, and marine life may receive significant air quality impacts from the Proposed Action or alternatives. Areas around missile launch sites and stationary sources of air pollution (e.g., power plants) are the areas most affected.

Emission calculations and air pollutant dispersion modeling were used to estimate air quality before and after the Proposed Action. Missile launch emissions were provided by Strategic Defense Command (Huntsville, Alabama). U.S. EPA emission factors were applied to calculate power plant, incinerator, fuel tank farm, and other stationary source emissions (EPA, 1985). The Industrial Source Complex (ISC) model (EPA, 1987) and the Rocket Exhaust Effluent Dispersion Model (REEDM) were used to estimate downwind air pollutant

concentrations from stationary sources and missile launches, respectively.

3.4.1.1 <u>Air Quality Regulation</u>

The Clean Air Act regulates air pollutants that are defined as criteria pollutants or noncriteria pollutants. The primary criteria pollutants are particulate matter less than 10 microns in size (PM10), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur oxides (SO_x), ozone (regulated as volatile organic compound emissions), and lead. Ambient air quality standards for these pollutants, established by the EPA, are presented in Table 3.4-1.

Other air pollutants not specifically regulated under the Clean Air Act are defined as noncriteria pollutants or toxic air contaminants. Toxic air contaminants currently are not emitted in appreciable quantities in USAKA. Ambient air quality standards have not been established by EPA for toxic air contaminants. Some individual states in the United States have developed ambient guideline concentrations for toxic air pollutants. Ambient guideline concentrations for hydrogen chloride (HCl) (Radian, 1987), the primary toxic air contaminant emitted from the solid rocket launches, include:

10 $\mu g/m^3$	(24-hour)	--	Maine
140 $\mu g/m^3$	(annual)	--	New York
2,000 $\mu g/m^3$	(1-hour)	--	Rhode Island
140 $\mu g/m^3$	(8-hour)	--	South Dakota
120 $\mu g/m^3$	(24-hour)	--	Virginia

No guideline HCl concentrations have been developed for Kwajalein. The U.S. Air Force uses the following impact criteria, developed by the National Academy of Sciences, for evaluating rocket launch impacts (U.S. DOT, 1986):

3,030 $\mu g/m^3$ (30-minute)--Public exposure limit
4,550 $\mu g/m^3$ (30-minute)--Emergency exposure limit

There are no guideline concentrations specific to aluminum oxide (Al_2O_3). Because Al_2O_3 is emitted from rocket launches as a particulate, the most applicable guideline concentration for short-term nuisance dust exposures is the 8-hour worker threshold limit value of 10,000 $\mu g/m^3$. For long-term public exposures, the ambient air quality standards (Table 3.4-1) for PM10 are most appropriate (U.S. DOT, 1986). Threshold limit values are thought to be conservative for short duration exposures of workers for relatively infrequent normal operations. Guideline concentrations for short-term public exposures are not available.

3.4.1.2 <u>Climate</u>

Climate in the Marshall Islands affects the dispersion of air pollutants and resulting air quality. The Marshall

Table 3.4-1
AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	EPA Standard PPM ($\mu g/m^3$)
Particulate Matter (PM10)	24-hour	-- (150)
	Annual	-- (50)
Nitrogen Dioxide (NO_2)	Annual	0.05 (100)
Carbon Monoxide (CO)	1-hour	35 (40,000)
	8-hour	9 (10,000)
Sulfur Dioxide (SO_2)	3-hour	0.5 (1,300)
	24-hour	0.14 (365)
	Annual	0.03 (80)
Ozone (O_3)	1-hour	0.12 (235)
Lead	Calendar quarter	-- (1.5)

Source: 40 CFR Part 50, National Primary and Secondary Ambient Air Quality Standards.

Islands climate is characterized as a tropical marine climate that varies little in temperature and humidity, but shows high variation in precipitation. Kwajalein, located less than 700 miles north of the equator, has a tropical marine climate characterized by relatively high annual rainfall and warm to hot, humid weather throughout the year. The principal rainfall season extends from May through November. On average, about 75 percent of the annual rainfall is recorded during this period.

Temperature. The average monthly temperatures on Kwajalein Island range from 80°F to 85°F, depending on season. Temperatures vary by 10°F to 15°F during the day (lowest in early morning and highest in the afternoon). Over a yearly cycle, the lowest recorded temperatures are about 70°F, and highest temperatures about 90°F (NOAA, 1987). Temperatures affect how high pollutants are carried in the atmosphere, thus affecting the downwind concentrations at ground level.

Rainfall and Relative Humidity. The relative humidity at Kwajalein is uniformly high throughout the year (75 to 85 percent). Kwajalein averages 100 inches per year, but has experienced lows of less than 70 inches and highs of greater than 149 inches. Intense tropical storms of short duration contribute to much of the total rainfall, and the incidence of storms varies from one year to the next.

Winds. Tradewinds from the northeast dominate most of the year, but are strongest from November to June. Summer winds tend to be weaker with some slack periods. The prevailing winds at Kwajalein Atoll blow from the northeast or east with an average velocity of 16 mph during the winter months, decreasing to 9 mph by late summer. Strong winds tend to increase atmospheric dispersion of air pollutants. The prevailing conditions are fairly consistent, occurring 80 percent of the time. Wind data for Kwajalein have been collected and are available from three sources: (1) Summary of Synoptic Meteorological Observations-Area 9, by the U.S. Naval Weather Service Command; (2) U.S. Air Force Weather Service; and (3) Local Climatological Data.

3.4.1.3 Existing Air Pollution Sources

Power plants, fuel storage tanks, solid waste incinerators, waste oil disposal, and transportation are the primary air pollution sources in USAKA. A list of air pollution sources and estimated emissions is presented in Table 3.4-2. Most of the sources in USAKA are combustion sources that produce particulate, NO_x, SO_2, CO, and hydrocarbon emissions. The power plants use diesel fuel and currently are the largest combustion air pollution sources on the islands. Solid waste incineration is the second largest air pollution source. The fuel farm is a source of hydrocarbon emissions but is not a source of the other pollutants.

In areas that meet ambient air quality standards, the EPA generally defines a large source of air pollutants as an activity that has the potential to generate more than 100 tons per year of an air pollutant [40 CFR 51.166(b)(1)(i)(a)]. Major modifications in air pollution sources, in terms of emissions changes, are characterized as increases in emissions above existing levels of 15 tons/year of PM10, 40 tons/year of NO_x, SO_x, or VOC, and 100 tons/year of CO [40 CFR 51.166(b)(23)(i)]. As shown in Table 3.4-2, Power Plant 1 on Kwajalein, the Roi-Namur power plant, and solid waste incineration have emission totals that would qualify as large sources of air emissions in USAKA.

Solid waste is burned on Kwajalein in an aboveground forced-air burning pit. Waste oil and solvents are open-burned in bermed collection pits--three on Kwajalein and one on Roi-Namur. Emissions from waste incineration were estimated using the annual waste quantities burned (GMP Associates, 1989). Air pollutants emitted from open-waste incineration depend on the characteristics of the waste being burned and include particulate matter, CO, NO_x, SO_2, organics, HCl, and other air toxics. Solid waste is loaded into the burning pit, ignited, and allowed to burn until the fire dies out. Then the ash is removed and the cycle is repeated. Air pollutant emissions from solid waste incineration are almost continuous over the day; however, the emissions rate varies according to the quantity of waste and temperature of the burn.

Meteorological and sounding rockets currently are launched from Kwajalein, Roi-Namur, and Omelek Islands in USAKA. Pollutants emitted from these launches include HCl and aluminum oxide (Al_2O_3). Air quality impacts from these launches are expected to be insignificant because of the periodic and short duration of emission and the relatively small quantities of propellants involved. The meteorological rockets have approximately 60 pounds of propellant and sounding rockets contain about 200 pounds of propellant.

3.4.1.4 Ambient Air Quality

Ambient air quality data do not exist for USAKA. However, air quality in most of the islands in USAKA is generally characterized as good because of the relatively small number of air pollution sources (Table 3.4-2) and because of the good dispersion produced by strong, persistent tradewinds and lack of topographic features to inhibit pollutant dispersion.

Dispersion modeling was performed to estimate existing air quality concentrations around the air pollution sources listed in Table 3.4-2 on Kwajalein. The model, ISC, was used because of its applicability to multiple point and area

Table 3.4-2
EXISTING AIR POLLUTANT EMISSION ESTIMATES[a]
(tons/year)

Island	Source	PM10	NO_x	CO	SO_2	VOC
Kwajalein	Power Plant 1 (13.5 MW)	111	1,114	290	134	31
	Power Plant 1A (10 MW)[b]	0	0	0	0	0
	Power Plant 2 (5.3 MW)	9	87	23	9	2
	Fuel tank farm	--	--	--	--	42[c]
	Transportation--motor vehicles	1[c]	7[c]	100[c]	<1[c]	12[c]
	Transportation--aircraft	5[c]	13[c]	42[c]	2[c]	35[c]
	Solid waste incineration[d]	43[d]	17[c]	228[c]	6[c]	81[c]
Roi-Namur	Power Plant (12 MW)	73	733	191	88	21
	Oil waste disposal[e]	Yes	Yes	Yes	Yes	Yes
Meck	Power Plant (2.8 MW)	6	61	16	7	2
Ennylabegan	Power Plant (0.8 MW)	5	45	12	5	1
Other Islands	*Power Plants (total)*	7	92	20	6	7

[a]Estimates are based on EPA emission factors (EPA, 1985), 1988 fuel use data for the power plants and tank farm, 1988 aircraft operations data, and 1988 motor vehicle miles traveled (Pan Am World Services, 1988).
[b]Power plant under construction and scheduled to begin operation in 1990.
[c]Source: Morrow, 1989.
[d]Includes oil waste disposal.
[e]Emissions data not available.

sources in flat terrain. Predicted concentrations were based on maximum short-term and annual average emission rates from the sources and actual meteorological data. These predicted concentrations were assumed to provide an upper estimate of existing background air quality around the sources for Kwajalein.

Maximum predicted concentrations from the dispersion modeling analysis are shown in Table 3.4-3. Concentrations of pollutants throughout most of the island, including the northern housing area, are within ambient air quality standards. However, some areas downwind (west) of both Power Plant 1 and the solid waste burning pit are predicted to exceed ambient air quality standards for CO, PM10, and NO_x. Other sources did not contribute significantly to the elevated CO, PM10, or NO_x concentrations. The CO and PM10 high concentrations are primarily attributable to the ground level open burning of solid waste (Morrow, 1989).

Table 3.4-3
PREDICTED AIR QUALITY CONCENTRATIONS
EXISTING CONDITIONS ON KWAJALEIN

Pollutant	Averaging Period	Second Highest Concentrations ($\mu g/m^3$)	EPA Ambient Air Quality Standard ($\mu g/m^3$)
PM10	24-hour	1,523.0[a]	150
	Annual	158.0[a]	50
NO_x	Annual	142.0[a]	100
CO	1-hour	187,000[a]	40,000
	8-hour	24,200[a]	10,000
SO_2	3-hour	742.0	1,300
	24-hour	98.2	365
	Annual	24.0	80

[a]Value exceeds ambient air quality standard.

Source: Morrow, 1989.

The NO_x exceedances are predicted to occur downwind of Power Plant 1. High NO_x levels were estimated downwind of the solid waste burning pit, but these levels did not exceed the NO_x standard under existing emission conditions (Morrow, 1989).

Concentrations of SO_2 are estimated to be less than standards. Existing fuels in the power plant have a 0.2 to 0.3 percent sulfur content. Higher sulfur fuels would produce greater SO_2 impacts (Morrow, 1989).

Dispersion modeling was not performed for the power plant at Roi-Namur. The power plant at Roi-Namur is approximately the same size and has about the same stack characteristics (i.e., height and exhaust temperature) as Power Plant 1 on Kwajalein. Air quality modeling for Power Plant 1 showed possible exceedances of the NO_2 standard (Morrow, 1989). Therefore, elevated levels of NO_x downwind (west) of the Roi-Namur power plant are possible. Annual use and emissions (Table 3.4-2) from the Roi-Namur power plant are about 65 percent of Power Plant 1. Assuming the modeling for Power Plant 1 applies to the Roi-Namur power plant, exceedances of the NO_2 standard are not expected to exist.

Existing air quality on Meck and the other islands is expected to be better than ambient air quality standards because of the good dispersion and lack of large air pollution sources.

3.4.2 NOISE

Noise is defined as sound (i.e., rapid fluctuations of fluid pressure) that is unwanted. Noise is usually evaluated in terms of sound pressure levels, stated in units of A-weighted decibels (dBA). High levels can cause adverse effects ranging from annoyance to hearing loss.

The region of influence for noise for this DEIS is defined as areas in the atoll in which even minimal noise levels are received. This area can vary, depending on the strength of the noise source. The loudest sources are expected to be the booster rockets used for missile launches. Typical maximum sound pressure levels associated with missile launches from USAKA will be 124 to 154 dBA at 250 feet. This level decreases with distance from the rocket due to geometric divergence and atmospheric attenuation of the sound energy. A conservative criterion for defining the boundary of the region of influence is a sound pressure maximum of 55 dBA. The 55-dBA level would be considered to be a very low daytime level. Missile launches as described above would generate maximum sound pressure levels of 55 dBA for short durations at a distance of about 16 to 26 miles. Therefore, the region of influence includes the area within 26 miles of the islands of Meck, Omelek, and Roi-Namur, from which launches will occur.

Many of the islands may experience operation or construction activities that generate sound at levels usually considered to be high. For example, large internal combustion engine-

powered mobile construction equipment can cause sound pressure levels of 90 dBA or more at 50 feet. These levels are much less than for rocket launches and the region of influence will not extend to islands other than those on which the operation or construction occurs.

Launches of missiles, sounding rockets, and meteorological rockets have been conducted for more than 30 years. The islands from which launches have occurred are Kwajalein, Roi-Namur, Meck, and Omelek.

Airports are located on Kwajalein and Roi-Namur Islands. For the USAKA Master Plan, the U.S. Federal Aviation Administration's Integrated Noise Model was used to evaluate aircraft noise. The model used information on aircraft types and volumes (see Section 3.11 Transportation), takeoff and approach parameters, and runway configuration to calculate annual average day-night sound level (DNL).

Department of the Army and standard acoustical engineering technical references were used to estimate the noise levels generated by power plants and miscellaneous other sources.

Noise level increases may be a concern on islands where construction is proposed, on islands where noise-generating equipment will be operated, on islands on which missile launches occur, and on neighboring islands. Measurements of existing noise levels are not available. Therefore, the description of the affected environment is based on knowledge and modeling of existing noise-generating activities.

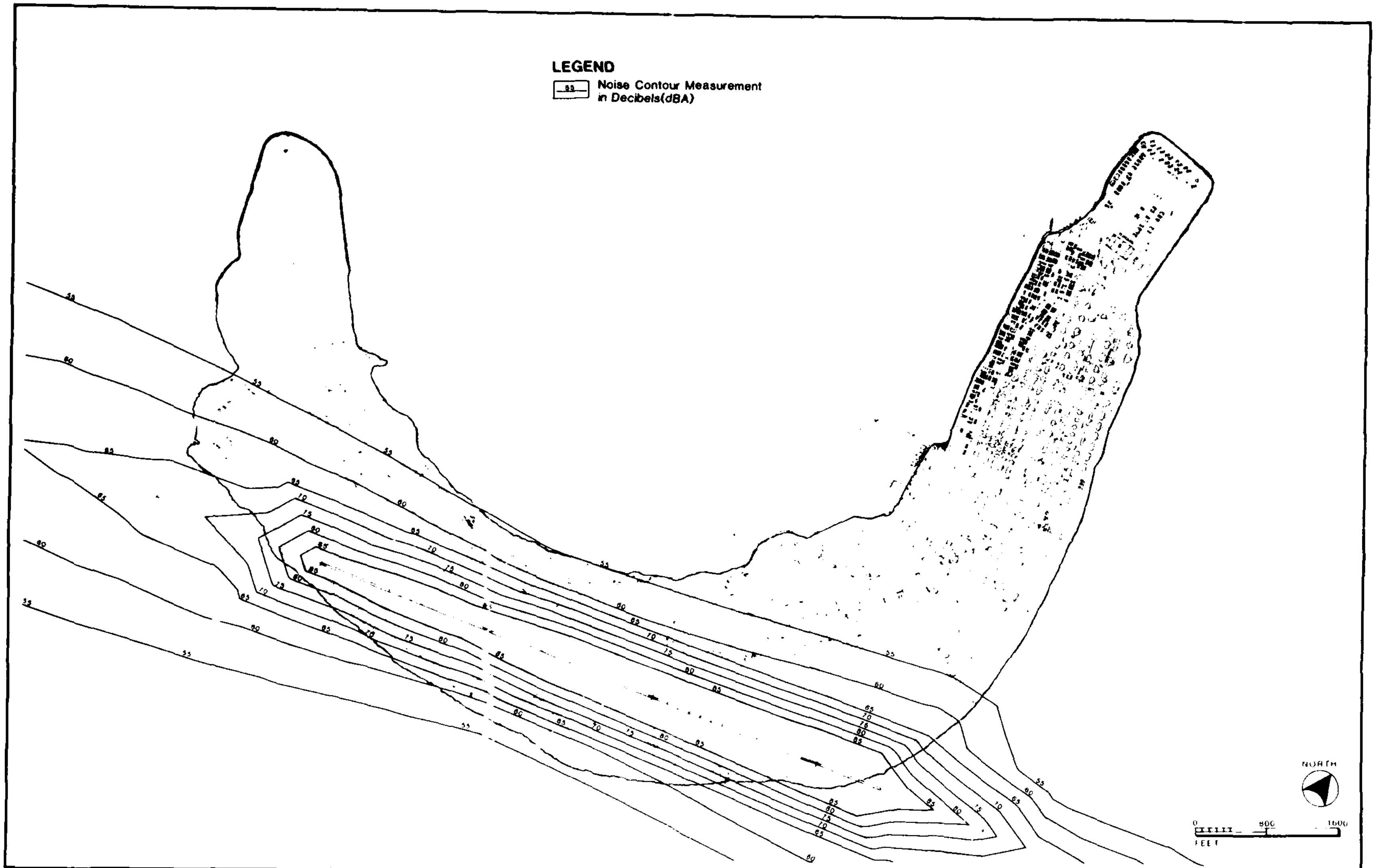
Workplace noise levels are maintained under levels mandated by the Department of the Army for occupational noise exposure.

Kwajalein Island

Noise is currently generated primarily by aircraft on Kwajalein Island. Power plants, sandblasting operations in the marine services yard, air conditioning units, and small diesel engine generators are also noise sources.

DNL contours have been prepared based on the annual average use of the airport. These contours are shown in Figure 3.4-1. A review of Figure 3.4-1 indicates that the 65 DNL contour is within the airport area, except for a small extension into some research and development operations south of the airport. Therefore, no noise-sensitive receptors are affected.

Two power plants exist at the present time on Kwajalein Island. Both are large diesel engine-generators. Power Plant 1 has nine 1,500-kW units and Power Plant 2 has six



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

AIRCRAFT NOISE CONTOURS

KWAJALEIN ISLAND

Figure 3.4-1

880-kW units. The power plant noise levels were estimated using the sound power level for individual units, the number of units operated concurrently, and the source-receptor distance. The engines in Power Plant 1 are not equipped with exhaust silencers. The resultant noise level in the family housing area located 3,000 feet to the north exceeds the 65-dBA DNL level. Power Plant 2 engines are equipped with silencers. The distance from Power Plant 2 to the 65-dBA DNL level is 1,900 feet. No noise-sensitive receptors are located within this area.

The source-receptor distances to the 65-dBA DNL level for air conditioning units are 95 feet and 170 feet for 10- to 50-ton units and 51- to 200-ton units, respectively.

Roi-Namur Island

The primary noise sources at Roi-Namur are aircraft operations and missile launches. Power plants and air conditioning units are also noise sources. DNL contours generated by the INM model for existing aircraft operations are shown in Figure 3.4-2. The 65-DNL contour is completely within the airport area and, therefore, no noise-sensitive receptors are affected. The maximum sound pressure levels from the HAVE-JEEP launches are illustrated in Figure 3.4-3. The 115-dBA occupational noise maximum allowable level is exceeded to 1,400 feet away from the launch location. All personnel on the island are workers directly involved in USAKA programs. Therefore, the occupational noise limits apply. Range safety measures in effect during launches provide the necessary hearing protection for personnel to reduce their exposure to allowable levels.

There is one power plant on Roi-Namur. It has nine 1,500-kW diesel engine-generators. The power plant noise level was calculated based on the number of units in operation. The source-receptor distance is 2,100 feet to the 65-dBA DNL level. No noise-sensitive receptors are located within this area. The noise levels for air conditioning units are the same as those described for Kwajalein.

Meck Island

The current primary noise sources are the 350-kW diesel engine-generators, helicopters, and building air conditioning units. The source-receptor distance for one engine-generator (typical operation) to the 65-dBA DNL level is 770 feet. There are no noise-sensitive receptors in this area. The noise levels for air conditioning units are the same as those described for Kwajalein.

Other Islands

There are currently no major noise sources on the other islands, other than occasional launches of meteorological or sounding rockets, helicopters, and small power plants.

The maximum noise level on Ennubirr during HAVE-JEEP launches on Roi-Namur reaches 82 dBA. This is generally considered to be an acceptable maximum sound pressure level.

3.5 ISLAND PLANTS AND ANIMALS

This section describes the plants, seabirds, shorebirds, and other terrestrial animals found on Kwajalein Atoll. The plants are in seven major vegetation types that range from broadleaf forest to exotic communities. Although birds are discussed most, coconut crabs, lizards, rodents, and domestic animals are also mentioned. Rare, threatened, or endangered species are discussed in Section 3.7; however, there are no listed, proposed, or candidate threatened or endangered terrestrial plants or animals on any of the USAKA islands.

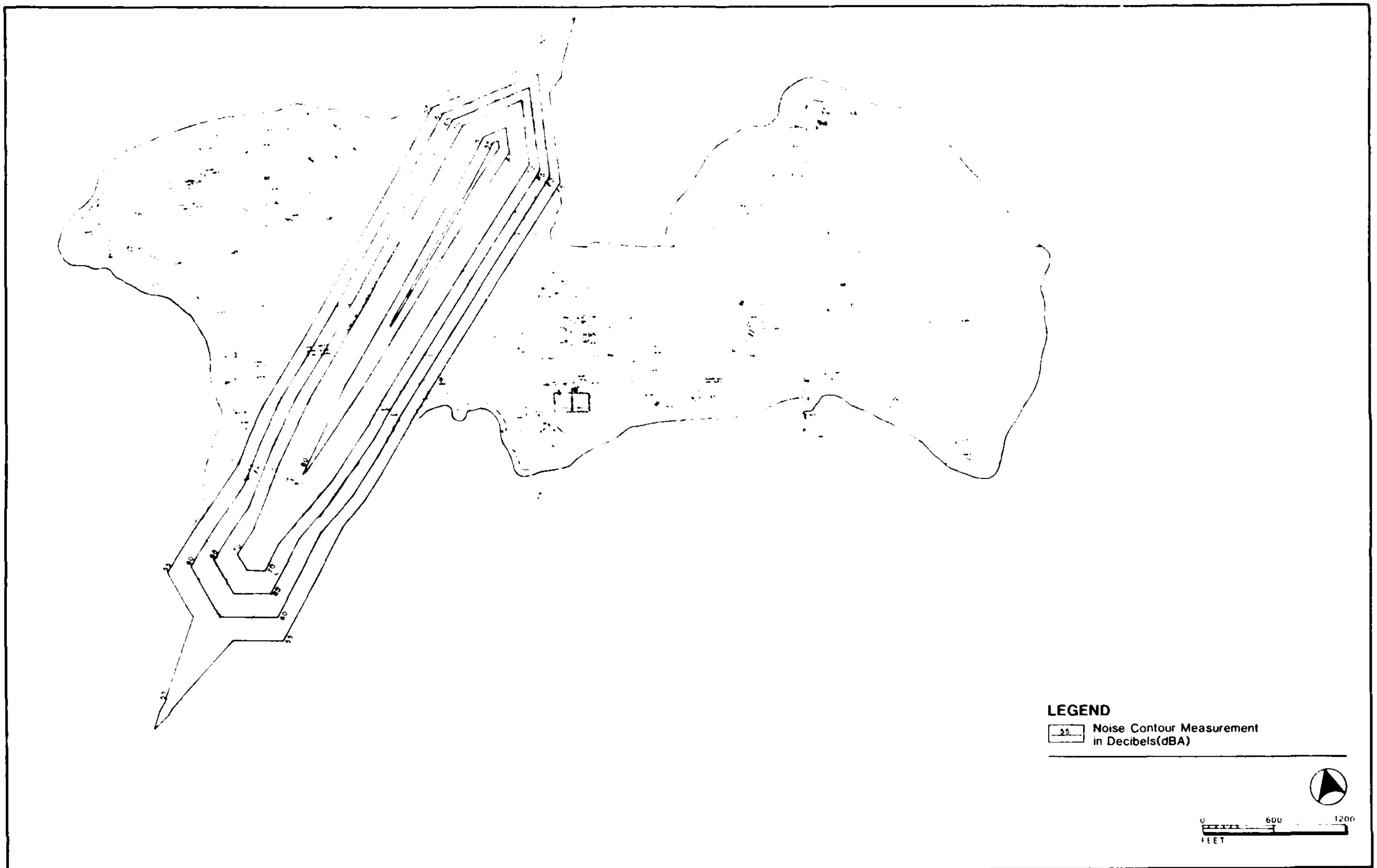
The region of influence includes all of the USAKA islands except Ennugarret Island, for which no impacts to island plants or animals are anticipated.

The discussion of island flora, birds, and other island fauna is summarized from the latest surveys (Herbst, 1988; Clapp, 1988) performed in support of this DEIS to provide baseline data. Table 3.5-1 is a summary of the characteristic biota of the USAKA islands of Kwajalein Atoll. Figures 3.1-2 to 3.1-11 show the location of important plant and animal features of USAKA.

3.5.1 ISLAND FLORA

In March 1988, a survey of the flora of ten USAKA islands was conducted (Herbst, 1988) to assess the botanical resources of the area in order to determine if any were of ecological importance and warranted protection, or if there were potential rare, threatened or endangered species. The islands surveyed have been disturbed by coconut plantations, the Japanese occupation, fighting and bombing during World War II, and USAKA operations. However, some outer islands have representative remnants of native atoll forests.

The vascular flora of the 11 islands surveyed comprises 315 species. Fifty-five (17 percent) of these are considered native to the Marshall Islands, but all are common, widespread strand species; none are endemic. Sixty-eight species (22 percent) are introduced, naturalized species, mostly weeds that are common throughout the Pacific Islands.

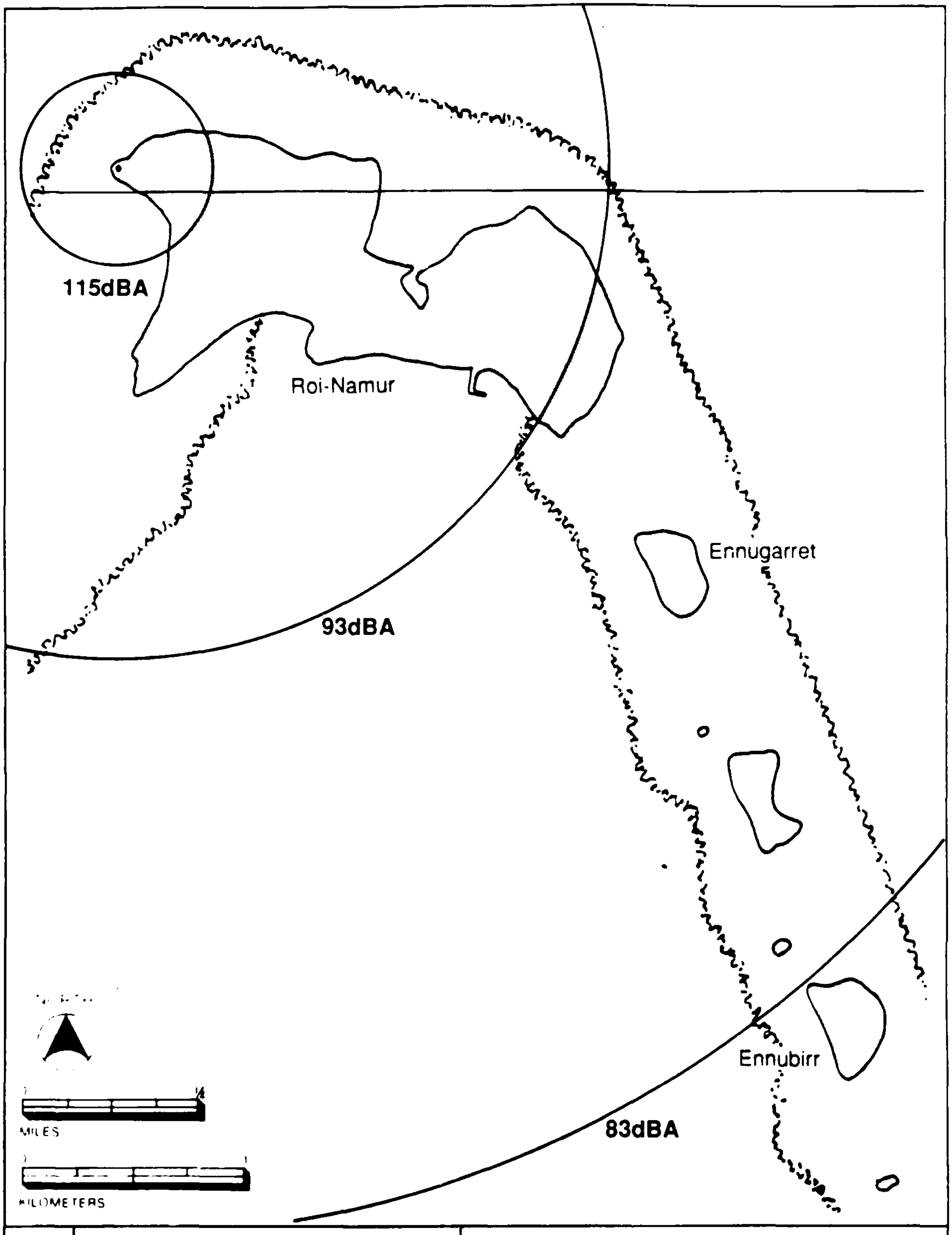


U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

AIRCRAFT NOISE CONTOURS

ROI-NAMUR ISLAND

Figure 3.4-2



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
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HAVE JEEP LAUNCH NOISE CONTOURS MAXIMUM LEVELS

Figure 3.4-3

Table 3.5-1
CHARACTERISTIC PLANTS AND ANIMALS OF SELECTED USAKA ISLANDS

Characteristic	USAKA Islands									
	Kwajalein	Roi-Namur	Meck	Ennylabegan	Legan	Illeginni	Gagan	Gellinam	Omelek	Eniwetak
Vegetation	Non-native weeds and grasses dominate.	Non-native weeds and grasses dominate; some coconut trees.	Non-native weeds and grasses dominate, with some native trees on northern end.	Central part cleared; grasses, weeds and other small plants dominate. Mixed broadleaf forest on northern and southern ends; with only *Pipturus* and *Allophylus* observed. Southeastern side has only *Pemphis* forest type on USAKA islands.	Southern end dominated by non-native grasses. Rest of island is best mixed broadleaf forest at USAKA.	Around buildings non-native grasses and weeds dominate. Some shrubs and mixed forest at southern end, and a large dense mat of Wedelia along the road.	One-half island mixed broadleaf forest; other half cleared, dominated by non-native vegetation.	Small wooded patch with *Pisonia* on northern end, with grasses and small plants on remainder.	Three small native forest patches; remaining two-thirds of island alien community type.	Western two-thirds of island has best *Pisonia* forest in USAKA; other areas sparsely vegetated.
Birds	Large numbers of shorebirds, particularly golden plovers and ruddy turnstones as well as several pintail ducks.	Shorebirds use southern tip and *Pemphis* bushes on western shore. Resting terns use southern tip. Reef herons along southwest shore flats and tidepools off north end of runway.	Mostly shorebirds; but some black-naped terns roost at southeast corner of runway.	White terns believed to nest in *Pemphis* forest. Brown noddies nest in forested parts.	Central lake attracts breeding birds and shorebirds. Broadleaf forest has most of the nesting white terns at USAKA, also brown and black noddies.	Black-naped terns roost at north end, and shorebirds occur in cleared areas not covered by Wedelia.	Black-naped terns believed resting; crested terns roosting at north point and west shore.	Wooded patch has large black noddy population. Sandpits to north and south and large pile of rocks at north end provide roosting habitat for black-naped terns. Ruddy turnstones use cleared areas.	A few black-naped terns observed resting on southwest and north points.	Largest nesting population of black noddies at USAKA, possibly entire atoll.
Other Animals	Lizards, rodents, dogs and cats.	Some dogs and numerous cats are present. Coconut crabs (*Birgus latro*) observed; rodents, lizzards, pigs, and ducks.	Lizards and rodents present.	Numerous pigs and chickens; some dogs and cats and several species of lizards observed. Rodents likely.	Coconut crabs (*Birgus latro*) observed.	Lizards, rodents, and a pair of cats were observed.	Lizards and one cat observed.	No other animals were seen.	No other animals were observed.	Lizards were observed.

Source: Summarized from Clapp, 1988 and Herbst, 1988.

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The remaining 192 species (61 percent) are cultivated plants. These are mostly ornamentals, but several small vegetable gardens exist on Kwajalein and Roi-Namur Islands. None of the plants found growing on the surveyed islands are candidates, proposed or listed, as threatened or endangered species. All species are widespread and most are typical of coral island floras.

Low coral islands generally have very small floras. Because of low species diversity, even relatively minor disturbances can cause major changes in the vegetation. Most of the islands surveyed had been disturbed to some degree in the past; however, different patterns of vegetation could be distinguished. The major vegetation types described below and the island descriptions in Table 3.5-1 are summarized from Herbst, 1988.

<u>The coconut forest</u> originally was planted and maintained by the Marshallese on land they had cleared for that purpose. Today most of the plantations on USAKA islands have been abandoned and other trees and shrubs have invaded to form a mixed forest, usually dominated by the coconut palm.

<u>The broadleaf forest</u> is the most common vegetation type in undisturbed places in the Marshall Islands. The trees are low to medium height and usually form a closed canopy. A few shrubs and a sparse to dense herb layer are found beneath the trees. The Pisonia forest consists of a pure stand of <u>Pisonia grandis</u>. Usually no other species of tree grows in this vegetation type except, perhaps, just at the edges of the grove. The ground cover is usually sparse or lacking, but in open areas, sparse to dense stands of grasses (Lepturus) or some exotic species such as <u>Bidens alba</u> can be found. The Pisonia forest probably was once the most common and widespread forest type on Indo-Pacific atolls; however, because these forests were established in good soils, and could be easily cleared, the early islanders converted them to coconut groves. Currently, good examples of this forest type are quite uncommon. The mixed broadleaf forest is the other subtype of forest found on the islands surveyed; it is the most common atoll forest.

<u>The Pemphis forest</u> vegetation type was found only on the southeastern side of Ennylabegan Island.

<u>Beach scrub</u> grows along the edges of the islands, especially along the windward and seaward sides of most islands. Scaevola and Tournefortia are the two most common species in this vegetation type, but Guettarda, Terminalis, Pemphis, Cordia, Sophora, and Suriana are frequent components. This vegetation type often borders the edges of atoll forests, forming the vegetation line back of beaches.

The Tournefortia forest comprises a low, open forest of Tournefortia argentea shrubs or trees. It is usually a pioneer association and is soon replaced by other vegetation types. The ground cover consists of Triumfetta, Fimbristylis, and vines such as Ipomoea, but often the cover is very sparse, and the ground will be mostly bare sand or rubble.

Alien or exotic community is the term used for man-induced vegetation associations of introduced species, often intermixed with a scattering of native plants. This vegetation type occurs on islands disturbed or altered by man: the mowed areas around buildings, helipads, and antennae; or, abandoned, developed areas or dumps that have become vegetated with weeds.

Secondary herbaceous vegetation associations were observed on many of the areas that were highly disturbed or completely denuded of their vegetation, then allowed to revegetate. Dense, pure, nearly impenetrable mats of Wedelia are the most common of such occurrences. The mat is often so dense that it prevents the invasion of any other species, including shrubs and trees. Vigna and Ipomoea are other, less dominant species common in this vegetation type.

3.5.2 BIRDS AND OTHER ISLAND FAUNA

The faunal survey was performed by the U.S. Fish and Wildlife Service (USFWS), and covered all of the islands controlled by USAKA except Ennugarret (Clapp, 1988). The purpose of the survey was to determine the nature of the wildlife resources, particularly avian resources and turtles, and to develop baseline data. The principal ornithological surveys of the 1950s and 1960s identified 30 species of birds from Kwajalein Atoll (Baker, 1951; Amerson, 1969). The principal source of new information for the atoll since then is a note by Schipper (1985) that added another 16 species. The latest survey by Clapp (1988) adds another six species and deletes one to bring the total known for the island to 51 (Table 3.5-2).

All of the common birds at Kwajalein Atoll are resident seabirds that nest on the ground or in vegetation on the islands, and migratory shorebirds that nest in the Arctic during the warmer months but spend the winter in Kwajalein Atoll and many other central Pacific atolls and islands. The nesting species are the more important of the two categories because of the greater vulnerability of chicks and eggs to predation and disturbance. Most nesting areas tend to be located on isolated, uninhabited islands. Changes to most of the islands of USAKA have reduced the existing breeding populations of seabirds to a small fraction of their former numbers. Loss of nesting habitat and consequent lower population levels of indigenous terns and

Table 3.5-2
BIRDS OF KWAJALEIN ATOLL

Common Name	Scientific Name	Status
Seabirds		
Black noddy	Anous minutus	Abundant resident; known to breed or has bred on Debuu, Edgigen, Edjell, Gagan, Gellinam, Illleginni, Legan, and Obella Islands, but probably breeds elsewhere as well.
Brown noddy	Anous stolidus	Common resident; known to breed or has bred on Debuu, Edgigen, Edjell, Gagan, Gellinam, Illeginni, Legan, and Obella Islands, but probably breeds elsewhere as well.
Black-naped tern	Sterna sumatrana	Common resident; known to breed only on Gagan, Meck, Omelek, and Gellinam, but probably breeds elsewhere as well.
Great crested tern	Sterna bergii	Common resident; has not been found nesting on Kwajalein Atoll, but probably breeds.
White tern	Gygis alba	Common resident; known to breed or has bred on Debuu, Edgigen, Edjell, Eniwetak, Ennumennet, Gagan, Kwajalein, Legan, Obella, and Roi-Namur Islands.
Little tern	Sterna albifrons	Accidental migrant.
Marsh tern	Chlidonias	Accidental migrant.
Sooty tern	Sterna fuscata	Uncommon offshore visitor.
Brown booby	Sula leucogaster	Uncommon resident; known to breed only on Oniotto Island.
Red-footed booby	Sula rubripes	Uncommon resident; know to breed only on Oniotto Island; common offshore visitor.
Great frigatebird	Fregata minor	Uncommon resident; known to breed only on Oniotta Island; frequent visitor in small numbers.
Sooty shearwater	Puffinus griseus	Common offshore migrant.
Wedge-tailed shearwater	Puffinus pacificus	Uncommon offshore visitor.
Red-tailed tropicbird	Phaethon rubricauda	Rare visitor; not previously reported from Kwajalein Atoll.
White-tailed tropicbird	Phaethon lepturus	Rare visitor; not previously reported from Kwajalein Atoll.
Mottled petrel	Pterodroma inexpectata	Rare offshore migrant; not previously reported from Kwajalein Atoll.
Shorebirds		
Lesser golden plover	Pluvialis dominica	Abundant migrant.
Black-bellied plover	Pluvialis squatarola	Uncommon resident.
Mongolian plover	Charadrius mongolus	Uncommon resident.
Wandering tattler	Heteroscelus incanus	Common migrant.
Whimbrel	Numenius phaeopus	Common migrant.

Table 3.5-2
(continued)

Common Name	Scientific Name	Status
Shorebirds (continued)		
Ruddy turnstone	Arenaria interpres	Abundant migrant.
Bar-tailed godwit	Limosa lapponica	Uncommon migrant.
Bristle-thighed curlew	Numenius tahitiensis	Uncommon migrant.
Sanderling	Calidris alba	Uncommon migrant.
Sharp-tailed sandpiper	Calidris acuminata	Uncommon migrant.
Pectoral sandpiper	Calidris melanotos	Accidental migrant.
Curlew sandpiper	Calidris ferroginea	Accidental migrant.
Marsh sandpiper	Tringa stagnatilis	Accidental migrant; not previously reported from Kwajalein Atoll.
Wood sandpiper	Tringa glareola	Accidental migrant.
Gray-tailed tattler	Heteroscelus brevipes	Uncommon migrant.
Hudsonian godwit	Limosa haemastica	Accidental migrant; not previously reported from Kwajalein Atoll.
Black-tailed godwit	Limosa linneaus	Rare migrant.
Greater yellowlegs	Tringa melanoleuca	Accidental migrant; not previously reported from Kwajalein Atoll.
Lesser yellowlegs	Tringa flavipes	Accidental migrant; not previously reported from Kwajalein Atoll.
Ruff	Philomacnus pugnax	Accidental migrant.
Latham's snipe	Gallinago hardwickii	Accidental migrant.
Oriental pratincole	Glareola maldivarum	Accidental migrant.
Other Birds		
Eurasian tree sparrow	Passer montanus	Common resident; introduced.
Pacific reef heron	Egretta sacra	Common resident; known to breed only on Roi-Namur, but almost certainly breeds on other islands in the atoll.
Green-winged Teal	Anas crecca	Uncommon migrant.
Northern pintail	Anas acuta	Uncommon resident.
Northern shoveler	Anas clypeata	Uncommon resident.
Mallard	Anas platyrynchos	Rare migrant.
Tufted duck	Aythya fuligula	Accidental vagrant.
Canada goose	Branta canadensis	Accidental vagrant.
Cattle egret	Bubulcus ibis	Rare vagrant.
Fork-tailed swift	Apus pacificus	Accidental migrant.
Sacred kingfisher	Halcyon sancta	Accidental migrant.
Common mynah	Acridotheres tristis	Introduced; now extirpated.
House sparrow	Passer domesticus	Introduced; now extirpated.

Source: Clapp, 1988.

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boobies has resulted from clearing for buildings, runways, helipads, antennae fields, and other structures.

Shorebird populations, on the other hand, may have benefited from the increase of area available for foraging and resting. Almost 40 percent of the identified species from the atoll are migratory shore birds (Table 3.5-2).

The non-avian terrestrial macrofauna is limited to a few species of lizards, rodents, coconut crabs, and introduced domestic animals.

On the ten USAKA islands visited, coconut crabs (Birgus latro) were only observed on Legan and Roi-Namur. A recent survey of the northern Marshall Island Atolls by the East West Center and the South Pacific Regional Environmental Programme (1989) recommends coconut crabs for special protection within RMI.

The island-by-island summary in Table 3.5-1 provides information on the most important populations of seabirds and terrestrial macrofauna.

3.6 MARINE BIOLOGICAL RESOURCES

Biological resources discussed in this section include marine plants, animals, and habitats found throughout the reefs of Kwajalein Atoll, and pelagic (open ocean-dwelling) species occurring in open ocean areas around the atoll. These biota are important for scientific reasons, for their recreational and subsistence value to the atoll's inhabitants, and to maintain the physical foundation of the islands. Principal reef species include reef corals, reef fishes, algae, echinoderms, mollusks, and other invertebrates. Principal habitat types include ocean reefs, lagoon reefs, lagoon floor and sand flats, harbors and piers, quarries, and seagrass beds. These features are illustrated by Figures 3.1-2 to 3.1-11.

The marine biological region of influence includes the reefs around ten of the USAKA islands at Kwajalein Atoll and the islands of Ebeye and Ennubirr, as well as the Kwajalein lagoon and RV splashdown areas northeast of the atoll (the broad ocean area, or BOA, shown in Figure 2.2-3).

Much attention has been paid over the years to marine areas potentially affected by USAKA activities. The most recent survey undertaken by the University of Hawaii Sea Grant Extension Service (Titgen, et al., 1988) covered all USAKA island shoreline, reef, and marine quarry sites except Ennugarret.

The biological data collected for this DEIS were derived from primary sources such as interviews with fishermen and other resource users, and extensive field surveys using standard transecting techniques and reconnaissance surveys of both terrestrial and marine environments around each island. Secondary sources included previous reports and other environmental documentation as well as other related Marshall Island biological surveys for comparison. Biological information for Ebeye was obtained from surveys in support of proposed projects (see Chapter 7, Bibliography).

3.6.1 CORAL REEF BIOTA

The macroscopic nearshore biota of Kwajalein Atoll consist of 657 known species that represent 180 families of the major phyla of marine plants and animals (Titgen, et al., 1988), and an additional 68 species and 40 families of nearshore microscopic organisms (e.g., blue-green algae) and minor phyla (e.g., tunicates) (Titgen, et al., 1988). Table 3.6-1 lists the characteristic features of species and families of the major phyla identified at selected USAKA islands during 1988.

Conspicuous and dominant biological features of the atoll are the coral reefs and associated assemblages of the species-rich fish fauna. An important feature of the atoll environment is the presence of several species of giant clams (*Tridacna* spp.), including one up to 3 feet in diameter (*Tridacna gigas*).

The reef structures are made by lime-secreting organisms, including reef corals (Anthozoans), calcareous algae plants, crustose coralline red algae (Corallinaceae), and green sand-producing algae (e.g., *Halimeda*). The living tissue of reef coral contains symbiotic algae or zooxanthellae that are responsible for a large portion of the productivity and the rapid calcification rates of the reef. Coral communities flourish only in clear, tropical, shallow depths (less than 120 feet) where sunlight levels are high, and where seawater maintains mean annual temperatures between 70° and 78°F (Wells, 1957). Corals will not flourish in the presence of sediments that can smother them or interfere with their ability to feed on small zooplankton.

According to Titgen, et al., (1988), the overall quality of the marine environment surrounding the USAKA facilities is good. Important areas include well-developed lagoon coral assemblages off Gellinam and Gagan Islands and the only reproductively viable population of *Tridacna gigas*, found off Gellinam during the 1988 survey.

Reef Corals. A total of 96 species of coral representing 14 families occurs within the reefs of Kwajalein Atoll. The family Acroporidae contains the dominant genus *Acropora* and

Table 3.6-1
CHARACTERISTIC FEATURES OF THE NEARSHORE MARINE BIOTA OF SELECTED USAKA ISLANDS

Reef Habitats	Kwajalein	Roi-Namur	Meck	Ennylabegan	Legan	Illeginni	Gagan	Gellinam	Omelek	Eniwetak
Ocean Reef										
Coral	Low coverage of branching and encrusting forms	Low coverage; staghorn and branching dominate	Severely disturbed	Low abundance, few species; encrusting forms	Sparse, due to natural events	50% coverage; diverse	--	Quarry dominates reef	--	No reef flat; pass reef has moderate abundance; brain and lobate forms
Algae	Abundant blue-greens, green, browns; corallines present	Abundant blue-greens, greens; browns and reds numerous	Primarily blue-greens	Mats, mostly of blue-greens and greens	Sparse red algal mats	Heavily grazed greens, blue-greens, browns, reds	--	Low diversity, blue-greens	--	Moderate; blue-greens and greens
Invertebrates	Numerous sea urchins, sea cucumbers, topshells, snails, and crabs	Not abundant, giant clams, snails, sea urchins, sea cucumbers	Hermit crabs, snails, crabs	Sparse	Moderate numbers, snails, sea cucumbers, crabs	Very abundant, cnidarians, giant clams, barnacles	--	Low diversity, crabs, hermit crabs, snails	--	Moderate diversity, giant clams, soft coral
Fish	Numerous eels, schools of mullet; gobies and wrasse	Moderate density, wrasses, butterfly, groupers, jacks, surgeons	Eels	Abundant seaward, surgeon, damsel, wrasses, butterfly, grouper	Abundant, especially surgeon fish	Very diverse, wrasses, damsel, angel, butterfly, snappers jacks	--	Low diversity	--	Resemble ocean reef fauna: surgeon, grouper, jacks, parrot
Lagoon Reef										
Coral	Lush coral: branching forms dominate; large knolls	Large beds, low diversity	Low coverage, some encrusting forms	Well developed; storm damage; large lobate forms	--	--	One of best reefs in atoll; high diversity; over 70% coverage; staghorn	Good development, 75% coverage, many forms including staghorn	Low abundance	--
Algae	Abundant greens, browns, reds	Not abundant, greens, blue-greens, browns, reds	Sparse, blue-green	100% coverage, greens, blue-greens, browns, reds	--	--	Moderate coverage of greens, reds, browns	Diverse reds, greens, blue-greens, browns	Moderate coverage, blue-greens, browns	--
Invertebrates	Abundant sponges, crabs, snails, hydroids, sea cucumbers	Large anemone colonies and worm clusters, giant clams	Sparse, topshells, sponges, tunicates	Soft corals dominate; topshells, giant clams, sea urchins	--	--	Rich, giant clams, sea cucumbers, soft corals, sea urchins, anemones	Diverse, giant clams, dominate, snails, anemones	Low diversity, giant clams, topshells, snails, sea cucumbers	--
Fish	Rich, diverse; parrot, rabbit, surgeon, rudder fishes, sharks	Moderate abundance, clown fish, groupers, wrasse, damsel	Moderately diverse, wrasses, damsel, squirrel, emporer	Abundant, convict tang, damsel, wrasses, grouper, rabbit	--	--	Diverse, abundant, squirrel, damsel, butterfly, wrasses, snappers, jacks	Abundant, wrasses, butterfly, damsel, snappers, parrot	Moderate, rabbit, surgeon, parrot, shark	--
Other	Green sea turtle	Green sea turtle	--	--	--	--	Green sea turtle	--	--	--

Table 3.6-1
(continued)

Reef Habitats	Kwajalein	Roi-Namur	Meck	Ennylabegan	Legan	Illeginni	Gagan	Gellinam	Omelek	Eniwetak
Lagoon Floor										
Coral	Small outcrops on sand, more dense on rocks, staghorn dominate	Low coverage, encrusting forms	--	--	--	--	--	--	--	--
Algae	Greens dominate in sand; greens, browns, reds on rocks	Large patches of green with some browns and reds	--	--	--	--	--	--	--	--
Invertebrates	Moderate numbers of anemones, snails, crabs, sea urchins	Abundant sea cucumbers; topshells, hydroids, crabs, tunicates	--	--	--	--	--	--	--	--
Fish	Diverse, abundant; rabbit, goat, groupers, wrasses, snappers, tangs	Moderate numbers, damsel, wrasses, surgeon, jacks, rudder	--	--	--	--	--	--	--	--
Harbor										
Coral	80% coverage, moderately diverse, branching forms	--	--	Large solitary forms and branching colonies	Diverse, 25% coverage, table coral	25% coverage, coral thickets of branching forms, lobate forms	--	3% coverage, encrusting forms	25% coverage	Less than 5% coverage, some branching and encrusting forms
Algae	Dense stands of greens, blue-greens, browns on bottom and pier	--	--	Sparse	Abundant, greens, browns, blue-greens, reds	Heavily grazed greens and blue-greens	--	Reduced, mostly blue-greens, browns	--	High coverage, mostly blue-greens, greens, reds
Invertebrates	Diverse, oyster, snails, barnacles, clams, hydroids, sea stars	--	--	Low abundance, burrowing shrimp	High diversity, sea urchins, giant clams, sponges, sea star	Moderate numbers, topshells, oysters, sponges, hydroids	--	Moderate, giant clams abundant; topshells, anemones, sea stars	--	Moderate, soft coral snails, giant clam, sea cucumbers
Fish	Low abundance, wrasses, angel, butterfly, surgeon, goat, grouper	--	--	Low abundance, wrasses, d[illegible]el, [illegible]rgeon	Medium diversity, wrasses, damsel, butterfly, jacks, box fish	Moderate diversity, damsel, parrot, grouper, surgeon	--	Low diversity, squirrel, surgeon, parrot, wrasses, butterfly	--	Low diversity, surgeon, parrot

Table 3.6-1
(continued)

Reef Habitats	Kwajalein	Roi-Namur	Meck	Ennylabegan	Legan	Illeginni	Gagan	Gellinam	Omelek	Eniwetak
Quarries										
Coral	Diverse, branching forms dominate	--	5% coverage, diverse table and branched forms	--	1% coverage but high density	--	Rich and diverse, brain, fire, encrusting, and mushroom forms	5% coverage, diverse, brain, fire, encrusting forms	50% coverage, diverse, branched and encrusting forms	--
Algae	Not abundant, browns and reds dominate	--	Moderate, mostly blue-green, reds, greens	--	High productivity of greens, browns, reds, blue-greens	--	Rich, greens, browns, reds, blue-greens	Moderate, browns, greens, reds	Moderate, greens and browns	--
Invertebrates	Sea cucumbers dominate; sea urchins, snails common	--	Diverse, sea urchin, sea cucumber, topshell, giant clams	--	Abundant, topshells, giant clams, sea urchin, sea star, ascidian	--	Diverse, soft coral, snails, sea urchin; abundant giant clams	Diverse, giant clams, sea urchin, topshells, shrimp	Moderate, sea urchins, sea cucumbers, giant clams	--
Fish	Diverse, angel, butterfly, wrasses, damsel, trigger, goat, file	--	Diverse, abundant; wrasses, damsel, butterfly, squirrel, goat, halfbeaks	--	Diverse, abundant; surgeon, buttefly, wrasses, shark	--	Most diverse, surgeon, parrot, wrasse, damsel, butterfly, goat	Diverse, abundant; surgeon, damsel, butterfly, parrot	Diverse, goat, halfbeaks, wrasse, mullet, butterfly, damsel	--
Seagrass Beds										
Plants	A few acres of seagrass beds in lagoon	Sizable seagrass beds, green algae	--	--	--	--	--	--	--	--
Invertebrates	--	Shrimp, limpets, sponges, barnacles	--	--	--	--	--	--	--	--
Fish	--	Juvenile nursery area; goby	--	--	--	--	--	--	--	--

Source: Titgen, et al., 1988.
Note: -- = data not reported.

nearly 40 species of coral. Other important families include the Pocilloporidae and Faviidae, each with more than 12 species of coral. Major forms include branching (e.g., *Acropora humilis*), encrusting (e.g., *Leptastrea purpurea*), staghorn (e.g., *Acropora formosa*), mushroom (*Fungia* spp.), and brain corals (e.g., *Favia* spp.).

Reef Fishes. The reef fishes of Kwajalein Atoll include 239 species and 46 families of bony fish and 9 species and 5 families of sharks and rays. The bony fish alone make up 36 percent of all the major reef species of the atoll. One family, Labridae (wrasses), contains 43 species. Other large families include Pomacentridae (damsel and angel fishes), with 26 species; Acanthuridae (surgeon fishes), with 20 species; and Chaetodontidae (butterfly fishes), with 17 species. Additional important families include Lutjanidae (snappers), Scaridae (parrot fishes), Serranidae (groupers), Mullidae (goat fishes), and Siganidae (rabbit fishes).

Macroscopic Invertebrates. Mollusks (snails and bivalves), crustaceans (shrimps and crabs), and echinoderms (sea cucumbers, sea stars, and sea urchins) are the dominant, noncoral macroscopic invertebrate species of the atoll. The 94 species and 42 families of snails and bivalves include topshells (*Trochus*), vermetid snails (*Dendropoma*), and five giant clams of the genera *Tridacna* and *Hippopus*. Included in the 80 species and 26 families of crustaceans are hermit crabs, burrowing and other shrimp, lobster, and edible crabs. The 48 species and 12 families of echinoderms include 16 species of sea cucumbers (e.g., *Holothuria atra*), and 12 species of sea urchins (e.g., *Echinothrix diadema*).

Marine Plants. The macroscopic marine plants of the nearshore environment of the atoll, all of which are attached to the substratum, consist of green (Chlorophyta), brown (Phaeophyta), red (Rhodophyta), and blue-green (Cyanophyta) algae and a single species of seagrass, *Halophila minor*. The 34 species and 10 families of green algae on the atoll include *Halimeda*, one of the more abundant alga of the reefs. Brown algae, which are not very abundant in tropical areas, include only 16 species and 6 families. *Ralfsia* and *Dictyota* are two of the most dominant types of brown algae. Of the 29 species and 13 families of red algae present in the atoll, the crustose coralline algae of the family Corallinaceae are the most important. This group, which includes *Porolithon onkodes*, is one of the major contributors to (and cementers of) the structure of the coral reefs.

Reef Habitats. One obvious aspect of coral reefs at Kwajalein Atoll is the presence of distinct physiographic and biologic zones. Patterns of zonation occur and are maintained primarily by the interaction of physical, chemical,

and biological processes--mainly those of accretion of reef deposits by corals, calcareous algae, and other calcium carbonate metabolizers; erosion; and sedimentation. Reef zones are most distinct in parallel bands that follow the long axis of a fringing or barrier reef platform.

Coral reef habitats dominate the marine biological environment at Kwajalein Atoll. Each species of reef life on coral atolls in the Marshall Islands, including Kwajalein Atoll, can be divided into one or more of the following typical habitats or zonations according to Ristvet (1987) (Figure 3.6-1):

- Lagoon--Defined as lagoon terrace (with slopes and crests of lagoon pinnacles) and lagoon reefs (that contain many patch reef flats)

- Island--The emerged portion of the atoll

- Seaward Reef Flat--Defined as back reef flat, reef flat, and coralline algal ridge

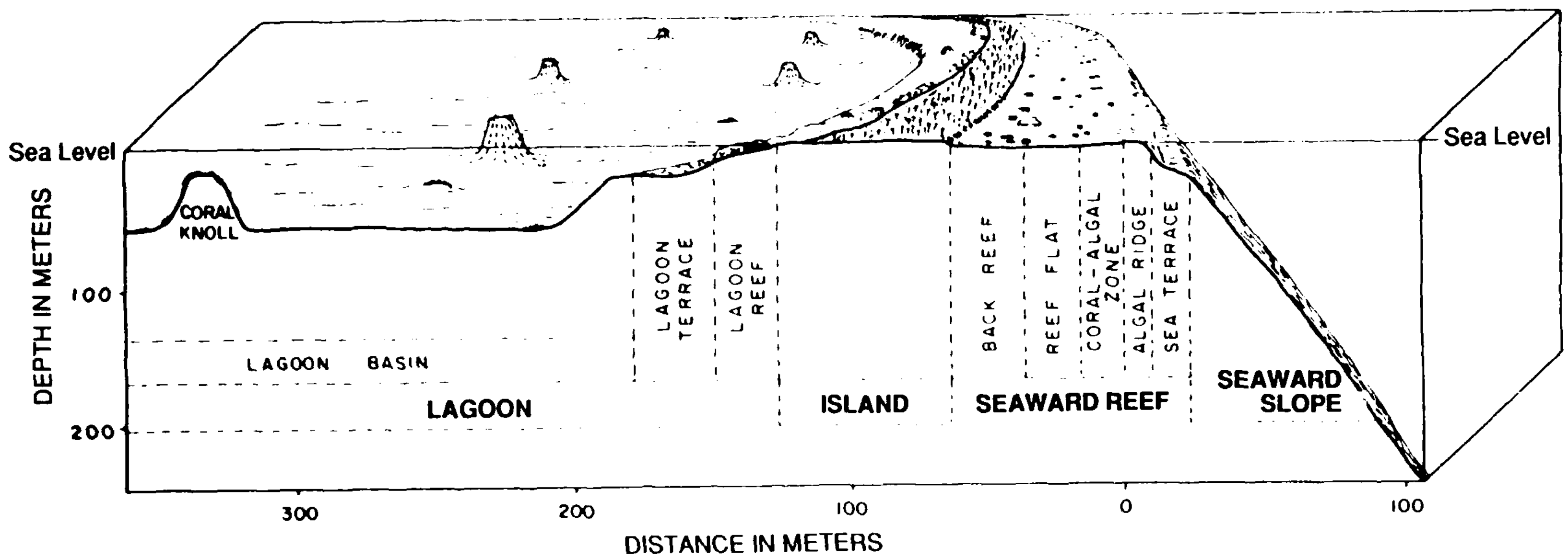
- Seaward Slope--Defined as windward spurs and grooves, terraces, and deep ocean slopes; and steep leeward ocean reef slopes

Different groups of reef organisms dominate each of these habitats. Virtually all support populations of fish, shellfish, and invertebrates of subsistence and cultural value. Additionally, the reefs and shorelines support both the feeding and resting of seabirds, and sea turtles (and their eggs) that have historically been important sources of dietary protein for native atoll inhabitants. Small seagrass beds are found in Kwajalein Atoll near Kwajalein and Roi-Namur Islands. Seagrass beds (also associated with coral reefs) are generally rich in edible fish and shellfish and are very rare in the Marshall Islands.

Reef habitats support the greatest variety and abundance of marine life yet to be reported in the world. Although the subsistence requirements of large human settlements can be supported from the harvest of reef species, reef fisheries are sensitive to overfishing, pollution, sediment accumulation, sewage discharges, dredging, and filling.

A summary of characteristic features of the nearshore marine biota is presented in Table 3.6-1. There are 657 species and 180 families of the macroscopic marine biota identified in the shallow marine waters of Kwajalein Atoll during the January-February 1988 survey (Titgen, et al., 1988).

In support of the tabular summary, the following island-by-island analysis describes these areas of significant biological value.



NOTE: After Ristvet 1987

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

REEF TO LAGOON ZONATION

Figure 3.6-1

3.6.1.1 Kwajalein Island

Dredging and filling has modified the natural habitat at Kwajalein island since at least the 1930s. Four significant habitat types are described below and illustrated in Figure 3.1-2.

Ocean Reef Flat. Because the reef flat is a relatively homogeneous, harsh environment, its biological assemblage is composed of a small, hardy group of plants and animals. This assemblage appears to be resilient to localized, non-chronic impacts and can rapidly recolonize disturbed areas.

The coralline algal zone is covered by water at all times and has good circulation even at low tide as a result of washover from waves breaking on the reef front. The substratum consists of crustose coralline algae and reef corals cemented into a very hard and wave-resistant framework. Overall coral coverage is low.

Lagoon Reefs. Previously existing lagoon and nearshore marine areas along Kwajalein's lagoon shoreline are now buried under fill land created by dredge and fill operations. Only a small remnant reef at the northern end of the lagoon shoreline remains relatively undisturbed (at Emon Beach) and appears to have survived or recovered from the dredge and fill operations that occurred during the mid-1960s. The Emon Beach site appears to be the only remaining well-developed coral reef habitat along Kwajalein Island's lagoon. Fish are moderately abundant along the shallow coral reef complex.

The interisland lagoon reef flat and slope north of Kwajalein Island are undisturbed and have a lush coral reef development. The large coral knolls at the dropoff to the terrace approach the water surface and are diverse and rich in coral (over 12 genera) and fish. Greatest coral diversity occurs on vertical ledges and overhangs. The coral knolls have abundant non-coral invertebrate fauna and algae flora. Fish diversity increases at the lagoon reef terrace and slope. There is high coverage by leafy algae although the fronds are covered by silt.

Adjacent to the garbage disposal ramp, which is located on the western end of the island, are aggressive parrot fish, rabbit fish, surgeon fish, and rudderfish (Kyphosidae) as well as marine turtles (Chelonia mydas) and black tip (Carcharhinus melanopterus) and white tip (Triaenodon obesus) sharks.

Lagoon Floor and Sand Flats. The majority of the lagoon bottom fronting Kwajalein Island is sand and algae with scattered small coral outcrops. Marine communities there have been degraded by past dredging. The rare seagrass

Halophila minor is present in a few areas on Kwajalein Island, although it is more abundant at Roi-Namur. Sea cucumbers are noticeably absent from the sand and algae beds.

Just north of Echo Pier, outside the harbor, narrow remnants of the original reef flat support a coral assemblage that approaches 80 percent coverage on the deeper portion (Titgen, et al., 1988).

Kwajalein's Quarries. Kwajalein Island has a series of quarries on its southern and northeastern ocean reef flats. The habitat and biota of the quarries vary somewhat from pool to pool, and the abundance and distribution are different. The Japanese pools appear to have more developed biota because they are older than the U.S.-dredged pools, and therefore have had more time for recolonization by marine life. The quarries on Kwajalein Island (especially U.S.-dredged) have a substantial amount of dredged fine sediment on the bottom that indicates that they do not flush well. During times of higher wave energy, the sediments can be resuspended and become abrasive to sedentary organisms, which can then be smothered. Indicator organisms typical of these fine-sediment habitats are deposit-feeding sea cucumbers. Roughly 30 fish species occurred commonly in all quarries on Kwajalein and throughout the atoll.

3.6.1.2 Roi-Namur Island

Four major marine biological habitats occur off Roi-Namur: ocean reef flats, lagoon reefs, piers, and seagrass beds (Figure 3.1-3).

Ocean Reef Flats. Remnants of the interisland reef between the Roi and Namur portions of the island are evident on the northern coast of the island where coral development is very poor. This semi-enclosed embayment has poor circulation and the water moving across the reef flat has deposited a fine coating of sediment on all surfaces.

The east and west ends of Roi-Namur have shallow reef flats and very strong currents. Coral coverage is low as a result of the strong currents and shallow depths.

The shoreline of the western side of Roi-Namur consists of sand except at the western point where currents scour the shoreline. Some smaller giant clam species are present but, in general, large invertebrates are not abundant. One large patch of the red algae, _Asparagopsis taxiformis_, was observed on the reef flat northeast of the runway extension site. Fish diversity is moderate (approximately 15 species) throughout the runway extension area.

Lagoon Reefs. The lagoon habitat on the eastern side of Roi-Namur is a depositional environment, with the bottom composed mostly of sand and gravel. However, there are large beds of branching coral, some of which measure over 30 feet across. The most outstanding component of the branching coral beds is a huge anemone colony that clings to the branches of one coral colony. Associated with this are hundreds of commensal clown fish. A small green sea turtle was observed just outside this area.

Seagrass Beds. The lagoon side of the island has been dredged for shipping access to the two piers. Some sizable beds of the seagrass *Halophila minor* are present. The diversity and number of juvenile fish suggest that this area might be a nursery ground for butterfly fish, damsel fish, surgeon fish, and wrasses. Shrimp or goby fish burrows are common in the sand. Juvenile fish dominate the fish assemblage in the fuel pier region. The only siting of a species of banner-fish on Roi-Namur occurred here.

Sediments become coarser near Yokohama Pier and seagrass is thicker. There is a warm water discharge upstream (east) from a sunken pontoon bridge associated with the heat exchange of KREMS radar. The rocks in the vicinity of the discharge are covered by white fuzz that might represent bacterial production (Titgen, et al., 1988).

3.6.1.3 Meck Island

The marine biological environment surrounding Meck (Figure 3.1-4) has been altered by extensive dredging in the lagoon. A large area of the lagoon reef flat was covered with fill, and most of the ocean reef flat has been quarried. The marine environment of Meck Island can be divided into the following categories: shoreline, shallow reefs, lagoon and harbor, and quarries.

Shoreline. Almost the entire island has been surrounded by a riprap revetment for shoreline protection. This riprap supports a large population of rock crabs, snails, and terrestrial hermit crabs. A natural cobble beach extends along Meck's ocean side in front of the revetment. The gently sloping back reef supports a typical simple reef flat biota consisting primarily of blue-green algae, hermit crabs, and some snails. The reef flat is pitted with solution holes that collect rocks and sediment. These holes support the above mentioned animals and some eels under the rocks.

Shallow Reefs. The only undisturbed interisland reef flats remaining at Meck are at the north and south ends of the island. These reef flats support a more diverse and abundant biota than is typical of exposed windward reef flats.

Lagoon and Harbor. Meck's lagoon has a man-made sand beach near the northern end. The marine biota of the lagoon appears to be recovering, but due to extensive dredging and filling there is little hard substratum left for coral reef development. Meck's lagoon is basically sand habitat.

Meck's Quarries. A series of six quarries has been excavated on Meck's outer ocean reef flat. They decrease in size, depth, and general biotic abundance toward the north. Their shape is generally rectangular. The edges were intentionally left jagged and irregular to create a more complicated habitat. The relief is also varied because armor stone blocks remain in some of the quarries. The overall effect is a diverse habitat and biota that is quite unlike that on the surrounding reef flat. Overall coral coverage is about 5 percent, but it approaches 50 to 60 percent on the knolls where there are areas of almost total coral coverage. Sea urchins are conspicuous. Fish are abundant and diverse in the quarries (over ten families of fishes recorded).

3.6.1.4 Ennylabegan Island

Ennylabegan (Figure 3.1-5) has a relatively unmodified shoreline except for some portions. Ennylabegan has some of the best potential nesting beaches for sea turtles of any of the USAKA islands. The offshore marine biological survey was conducted only adjacent to the USAKA portion of the island (Titgen, et al., 1988). Three significant habitats--lagoon reefs, harbors and jetties, and ocean reef slope--are discussed in more detail below.

Lagoon Reefs. The lagoon reef is well developed but shows signs of recent coral damage, probably from Tropical Storm Roy (1988). At greater depths, there are some strikingly large brain coral heads (*Hydnophora*) and large branching corals (*Pocillopora eydouxi*). The entire reef area is covered by an algal mat of varying thickness. Algal abundance decreases near and in the harbor. The fish assemblage increases rapidly in abundance from the shallow reef flat to deeper coral reef terraces. Fish diversity and abundance is greater at a depth of 13 feet.

Harbor and Jetties. The harbor is formed and protected by the Japanese pier and two barges that were sunk to serve as jetties. Its lagoon side is covered by extensive crustose coral colonies and the bottom has large numbers of the vermillion tube coral. The dredged harbor bottom is sandy and appears to have a shallow anoxic layer.

Ocean Reefs. The shallow scoured reef flat in the breaker zone has relatively few species and low abundance. Outside the breaker zone, coral coverage increases to 10 to 20 percent. About 165 feet from shore, where water depth reaches

6 to 7 feet, the environment becomes richer. A developed canyon system begins at a depth of about 10 feet with a relatively diverse coral assemblage on the ridges and cobbles in the canyons. There is an algal mat on most of the reef rocks. The fish population increases at both distance from shore and depth.

3.6.1.5 Legan Island

Important marine biological habitats at Legan (Figure 3.1-6) include harbor and jetties, a quarry hole, and shallow reefs. The ocean side of the island has a sloping reef platform that extends about 300 feet seaward and descends to a depth of 7 to 10 feet. Although scoured, the bottom has a coating of fine algal mat. Fish are abundant, especially grazers such as surgeon fishes.

Harbor and Jetties. The dredged harbor bottom is almost barren of large marine life. Fish diversity is moderate to high within the harbor and includes wrasses, damsel fishes, butterfly fishes, and pipe fishes (Syngnathidae). The bench outside the harbor has a well-developed coral reef assemblage. Although coral coverage is only 20 to 30 percent, it is quite diverse and includes table corals. The abundance and diversity of large invertebrates are also higher on the outside bench, but the fish diversity is low. Fish abundance increases along the perimeter of the beach and onto the lagoon terrace. The only siting of the black polka dot yellow box fish (Ostracion cubicus) occurred here.

Legan's Quarry

The Legan quarry is located by the "heel" of the island at the southwest end. There is generally low faunal coverage in the quarry, but relatively high diversity for a small quarry. The quarry is unusual because it has high densities of black tunicates that are also found in other localities around the island. The fish assemblage is diverse and fairly abundant despite the quarry's small size. In addition to the usual species, the only occurrence of the butterfly fish Chaetodon meyeri was documented here.

3.6.1.6 Illeginni

Illeginni's important marine biological habitats (Figure 3.1-7) include shallow reefs, the ocean reef slope, and the harbor and channel.

Shallow Reefs and Ocean Reef Slope. At a depth of 13 feet, the coral diversity increases greatly. At greater depths, coral coverage is high on the ridges (50 to 80 percent). About half of the coral coverage in the area is by Alveopora sp., which is quite unusual. Large invertebrates are more abundant in deeper water on the slope, including tunicates,

clams, and barnacles. Species on the nearshore shallow wave-swept platform include surgeon fish, trigger fish, and small damsel fish. Farther seaward, where lush ridges and canyons occur, reef fish diversity and abundance increase tremendously. Also observed in this lush environment were four species of sharks, including a whitetip Triaenodon obesus, blacktip Carcharhinus melanopterus, silvertip , and gray reef Carcharhinus amblyrhynchos.

Harbor and Channel. The fuel pier is at the base of the harbor and has the least biological development. Across the harbor channel, there is a rich assemblage of coral along the dredged reef face that shows 20 to 30 percent coral coverage and includes many of the same species that occur on the other side of the harbor. There is a rich section along the curve in the harbor that has 50 to 60 percent coral coverage. The juvenile, orange-color phase of the surgeon fish Acanthurus mata is especially abundant.

3.6.1.7 Gagan Island

Gagan (Figure 3.1-8) is located on the northern windward atoll rim on a long continuous section of reef flat with no passes, and it has not been affected much by human activity. The lagoon has only been dredged in the harbor region, which is protected by two rock jetties. The ocean reef flats essentially show the same biological composition and zonation as reported for the reef flats off other undisturbed windward islands.

Lagoon Reefs. Gagan has one of the most luxuriant lagoon coral reef systems observed adjacent to a USAKA island. Offshore from the southern sandbar, the lagoon reef extends north to the southern harbor jetty, which has extensive coral coverage that approaches 80 percent on the knolls. The area is also rich in other macroinvertebrate species, soft corals, anemone fish and associated large anemones, as well as topshells and sea stars. Many species of algae are present. The fish assemblage is exceptionally diverse and abundant. Also observed were a green sea turtle and a blacktip and whitetip shark. Coral coverage on the jetty riprap approached 80 percent in places. Staghorn coral thickets have recolonized the dredged outer harbor bottom with coverage as high as 20 to 30 percent. There is a barren, dredged area with poor circulation and warm water adjacent to the northern jetty. A well-developed lagoon coral reef continues beyond the north end of the dredged area and the island. The biota and structure are similar to those found at the southern end of the island, although the reef is larger.

Gagan's Quarry. The ocean reef flat is relatively wide and has a typical windward reef flat structure and biota. The quarry biota is quite rich and diverse. The Gagan quarry

has the most diverse fish fauna noted in any of the quarries, including adults and juveniles of many species. In addition to the usual species, schooling mullet, large parrot fish, and several pairs of dragon wrasses Novaculichthys taeniourus) were present.

3.6.1.8 Gellinam Island

Important marine biological habitats off Gellinam (Figure 3.1-9) include lagoon reefs, the harbor area, and shallow reef flats. The lagoon adjacent to Gellinam appears unaffected by development except for the harbor area that has been dredged. A riprap revetment, which extends beyond both sides of the harbor jetties to protect the helipad and other facilities, supports a large population of grapsid crabs.

Lagoon Reefs. Coral reef development is extensive in the lagoon on both sides of the harbor. The margin of the island has a narrow lagoon reef flat that descends to a sand bottom at a depth of 13 to 16 feet. Coral knolls and mounds are abundant, with coral coverage approaching 80 percent on hard substratum. The coral reef development also supports an abundant and diverse macroinvertebrate fauna and algal flora, including non-coral coelenterates, anemones, and large gastropods such as *Trochus* and *Strombus*. Giant clams are fairly abundant. Most of them are relatively small (less than 6 inches); however, a coral mound in deeper water north of the harbor marked the site of eight individuals of the largest and rarest species of giant clam (*Tridacna gigas*), ranging in size from 6 to 31 inches. This is the largest giant clam population found during the marine survey of USAKA reefs and shorelines (Figure 3.1-9). The fish assemblage is moderately abundant adjacent to both sides of the harbor.

Harbor Area. Fauna and flora decrease in the harbor area and on the jetties. The dredged harbor bottom is devoid of all but a few live coral fragments. The rocks of the jetties support snails, sea urchins, and giant clams. There are a few large anemones, and a large crown-of-thorns sea star (*Acanthaster planci*) was feeding on coral.

3.6.1.9 Omelek Island

Important marine biological habitats off Omelek (Figure 3.1-10) include shallow lagoon reefs, harbor and jetties, and quarry holes.

Shallow Lagoon Reefs. The high wave energy in the lagoon results in considerable scouring of the intertidal and shallow coastline, with the harbor offering only partial protection from surge. Several fish schools swam through

the area, including rabbit fish, surgeon fish, parrot fish, and fusiliers.

Harbor and Jetties. The southern jetty was built on an undredged section of lagoon reef flat. Colonial organisms such as tunicates and bryozoans occur on the inner jetty walls. Coral coverage approaches 50 percent on the shallow portion of the southern jetty, as opposed to 5 percent coverage on the dredged northern wall. The northern jetty is oriented perpendicular to the wave direction and is subject to high wave energy and scouring. The southern jetty, however, is at a 45-degree angle to the wave direction, thereby protecting the fauna on the inside of the jetty from high wave energy and scouring.

Omelek's Quarry. Omelek has a single, relatively large quarry on its outer ocean reef flat. The high biological abundance and diversity are probably due to the complex design, habitat diversity, and good water circulation. The coral fauna is very diverse in the quarry with 100 percent coverage in some localities, and an overall coverage of about 50 percent on the walls. Algal abundance and diversity decreases toward the hook, and only some algal film occurs at the end of the hook. Fish are abundant and diverse in the quarry, ranging from juveniles through adults. As in other quarries, the diversity and abundance of fish is greater along the landward side of the quarry hole. Small fish are particularly abundant on the landward side.

3.6.1.10 Eniwetak Island

Important marine biological habitats off Eniwetak include the harbor area and the reef facing the deep pass (Figure 3.1-11).

Harbor Area. The harbor area on the western end of the island has breaking waves and a scoured bottom. There are only a few small encrusting corals in shallow water. Three species of soft coral dominate the non-coral macroinvertebrates. The density of vermetid snails is higher than at other survey sites. Algal coverage in the harbor is relatively high, possibly due to nutrient input from the forest and birds.

Pass Reef. A shallow, 65-foot-wide terrace descends to a depth of 16 feet, then drops into the channel along a 60-degree incline. The shoreward side of the terrace had staghorn and table coral thickets. However, these had been sheared off, probably by Tropical Storm Roy. This was undoubtedly the source of substantial coral rubble along the southern shore. Below 6 to 7 feet in depth, coral coverage reaches 50 percent or greater, with strikingly large heads of brain coral up to 6 to 7 feet in diameter. There are

also large colonies of over 20 species of additional corals. There are several clams of the species Tridacna maxima, and Lithophaga zittelliana density is high on the shallow terrace, reaching densities of 35 to 60 per square yard. The fish species found offshore of Eniwetak Island along the inner channel wall resemble an ocean reef fish population despite its lagoonal location. Because of increased habitat diversity and complexity, the variety, size, and abundance of fish were substantially higher compared with other lagoon environments.

3.6.1.11 Ebeye Island

A marine biological survey from Ebeye to Ninge was undertaken (Brewer and Associates, 1984) as part of the proposed Kwajalein Atoll Causeway project (U.S. Army Corps of Engineers, 1985). Brewer divided the oceanside marine environment into the following habitats: seaward reef flat (rubble beach, elevated intertidal reef flat), lower reef flat (low relief reef flat and high relief reef flat), and interisland reef flat.

Seaward Reef Flat. A rubble beach zone, 1 to 20 feet in width, characterized most of the exposed windward shoreline. This zone was dominated by hermit and grapsid crabs. Below and seaward of the rubble beach zone is a broad, elevated intertidal reef flat that is distinguished by a mat of blue-green algae. This zone is exposed at low tide level, resulting in little biological diversity. Various marine snails, sea anemones, tidepool blennies, and juvenile fish were present.

Lower Reef Flat. This zone typically ranged between 20 to 25 feet in width and was destroyed in large part north of Ebeye as a result of quarrying activities. The absence of corals suggests that this zone is exposed during extremely low tides. Turf algae, urchins, and the money cowries (snails) were dominant marine invertebrates. The high relief reef flat is distinguished from the low relief reef flat by the presence of large limestone boulders, rocks, and slabs that have been cast up during storm wave activity. Various species of algae occur in the more protected reaches of many large boulders. Barnacles, mussels, and tube dwelling polychaete worms were present. Several species of sea urchins and sea cucumbers were also present, but mollusks (except the money cowry) were not especially abundant. Corals were scarce, as were fishes, although distinct algal cropping was apparent in most areas indicating that during high-tide periods the reef flat is grazed by herbivorous species of fish and invertebrates. Blennies and juvenile damselfishes were common.

Interisland Reef Flat. Brewer and Associates (1984) indicated that the interisland reef flat along the Ebeye-Ningi

corridor has limited biological diversity, but a greater diversity of marine organisms was reported between Ebeye and South Loi due to the deeper water habitat than is found on the normally shallower reef flat.

Tridacnid clams were only rarely observed; however broken shells litter the rubble zone.

Ebeye's Quarry. A biological survey 18 months after excavation of Ebeye's quarry in 1983 identified active coral colonization under way, 21 species of fish representing 10 families, sea urchins, sea cucumbers including synaptids, and large topshell *Trochus* (Brewer and Associates, 1984).

3.6.2 OTHER MARINE BIOTA

There is no known source of information immediately available concerning the deep-ocean resources and environment around the Kwajalein Atoll. Any discussion about these resources must rely on studies in other areas of the Pacific Ocean. Scientists using a deep diving submersible (Makali'i) surveyed the deep lagoon and offshore benthic community of Eniwetak Atoll (Devaney, et al., 1987). Mineral exploration and precious coral harvesting provide other sources of information.

This category primarily covers pelagic marine life typical of that found in the open seas of the BOAs north and east of the atoll. Nutrient levels and associated phytoplankton levels are quite low in the open ocean. Although no measurements were made of open ocean waters at Kwajalein Atoll, chlorophyll-A concentrations (indicator of phytoplankton levels) taken at Johnston Atoll, 1,500 miles northeast of USAKA, were below the 0.20mg/m^3 detection limits (JACADS EIS, 1988). Zooplankton is probably very diverse and consists of herbivores, carnivores, larvae, and adults, representing most phyla. Plankton continually drift through on oceanic currents. Johnson (1954) reported concentrations of zooplankton inside Marshall Island lagoons to be two to four times as abundant as in oceanic waters outside the lagoon. Zooplankton measured inside the USAKA lagoon (Amesbury, et al., 1975) was primarily larval crustaceans.

Larger carnivores such as tunas (Family Scombridae) are found in the general open ocean area around Kwajalein Atoll. Commercial fishing activity in the area surrounding the Marshall Islands is primarily by Japanese tuna longliners. Most of this effort is extended during the winter months (October to April). Taiwanese longliners occasionally fish north of the atoll. These vessels make trips of several months duration and freeze their catches. Foreign commercial fishing activities and resulting catches are not documented.

Although there is no information available to determine migratory patterns of marine mammals in the Kwajalein area, whales and dolphins have been observed in the atoll.

3.6.3 FISHING

Kwajalein Atoll fishermen were interviewed (Titgen, et al., 1988) with many stating that fish are plentiful and that they have no difficulty locating or catching fish for any occasion. There are no catch records; therefore, it is difficult to evaluate the history of fish catches for the atoll. Because most target species are pelagic (oceanic) species of gamefish, not dependent on coral reefs, it is unlikely that such species will be affected by changes in the reef environment or by overfishing in the atoll. Moreover, many Marshallese at the atoll fish only occasionally. On Kwajalein Island, there are no recognized, full-time, commercial fishermen, nor are there fish catch records for any of the islands of the atoll.

Island Fisheries

Fishing has historically been of cultural and subsistence importance to the Marshallese people. Of the 11 USAKA islands, the fishermen interviewed reported that they catch fish in the vicinity of eight USAKA islands plus Gugeegu (a previously leased island)--only Omelek and Gellinam Islands were unmentioned. As stated above, most target species include pelagic fishes as well as lobsters, crabs, and sea turtles. Table 3.6-2 lists the most commonly reported fish caught in the atoll for the selected islands of interest.

The waters around Kwajalein Island are described as good fishing grounds for many reef fish and lobster (wor). Specific fishing areas include the lagoon for pompano, the ocean reef terrace off the Kwajalein airport runway for flying fish, and off the northwestern tip of the island for flagtail fish. Kwajalein fishermen also fish at several adjacent islands, such as Ennylabegan and Legan. Both Ebeye and Kwajalein fishermen catch pelagic species (e.g., skipjack tuna) nearly year round off the southern end of the atoll. According to these fishermen, many of whom have fished off Kwajalein Island for 10 to 15 years, there has been no noticeable decline in the amount of fish caught around Kwajalein Island during the past decade.

Roi-Namur's best fishing ground is located on the reef flat southwest of the Roi-Namur runway. The fish assemblage is both abundant and diverse, with ten species harvested regularly, including yellowtail parrot fish and wrasses. Ennubirr fishermen also fish for snapper along the lagoon reef and for convict tang at the northern tip of the island. The North Pass, which is located southwest of Roi-Namur

Table 3.6-2
COMMON, SCIENTIFIC, AND LOCAL NAMES OF THE MOST FREQUENTLY CAUGHT
REEF AND PELAGIC FISH SPECIES BY KWAJALEIN ATOLL FISHERMEN

Island	Island Fishing: Reef Species: Common Name	Reef Species: Scientific Name	Reef Species: Local Name	Pelagic Species: Common Name	Pelagic Species: Scientific Name	Pelagic Species: Local Name
Kw.jalein	Unicorn fish	Naso spp.	Mone	Skipjack tuna	Katsuwonus pelamis	Lojabwil
	Squirrel fish	Myripristis sp.	Mon and jera	Dolphinfish	Coryphacha hippurus	Koko
	Goat fish	Mulloides	Jome	Wahoo	Acanthocybium solandri	Al
	Mullet	Valamugil sp.	Iool	Blue marlin	Makaira nigricans	Lojkaan
	Grouper	Valiola sp.	Momo			
	Rainbow runners	Elagatis bipinnulata	Ikaidik			
	Gray job fish	Aprion virescens	Laum			
	Flying fish	Cypselurus poecilopterus	Jojo			
	Flagtail fish	Kuhlia mugil	--			
	Pompano	Carangoides sp.	--			
Roi-Namur	Yellowtail	Seriola sp.		Dolphinfish	Coryphacha hippurus	Koko
	Parrot fish	Scarus sp.	Kilkil	Skipjack tuna	Katsuwonus pelamis	Lojabwil
	Wrasses	Labridae	Mera	Wahoo	Cacanthocybium solandri	Al
	Rabbit fish	Siganus spp.	Muramor	Barracuda	Sphyraena barracuda	Nutwa or jujukop
	Goat fish	Mulloides	Motal			
	Surgeon fish	Acanthurus spp.	Bwilak			
	Snapper	Lutjanus spp.	Jato			
	Grouper	Valiola sp.	Jawe			
	Convict tang	Acanthurus triostegus	Kupan			
Meck	Emperor	Lethrinus spp.	Mejmej	Dolphinfish	Coryphacha hippurus	Koko
	Snapper	Lutjanus spp.	Riuing	Barracuda	Sphyraena barracuda	Ni, tua, jujukop
				Skipjack tuna	Katsuwonus pelamis	Lojabwil
				Blue marlin	Makaira nigricans	Lojkaan
Ennylabegan	Rabbit fish	Siganus spp.	Muramor	Blue marlin	Makaira nigricans	Lojkaan
	Striped surgeon fish	Acanthurus lineatus	Kwil	Dolphinfish	Coryphacha hippurus	Koko
	Blacktip shark	Carcharhinus melanopterus	Boko			
	Striped surgeon fish	Acanthurus lineatus	Bwilak			
Legan	1			1		
Illeginni	White-lined cob	Variola louti	Letjebjeb	Blue marlin	Makaira nigricans	Lojkaan
	Grouper	Valiola sp.	Olalo, joanuron, jowame			
	Mullet	Valamjgil sp.	Iool			
Gagan	Snapper		Jetar	--		
	Emperor	Lethrinus spp.	Mejmej			
Gellinam	1			1		
Omelek	1			1		
Eniwetak	1			Present		

[1] None reported.

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Island, provides the closest ocean outlet for fishermen from Roi-Namur and Ennubirr Islands who fish for migratory fish such as dolphinfish. Barracuda are caught in great quantities along the ocean reef terrace.

Meck Island, located adjacent to the Eniwetak Passage, has good fishing grounds for reef fish, such as emperor, on the southern lagoon side. As with other channels, Eniwetak Passage affords access to the ocean with considerable trolling opportunities for pelagic species such as blue marlin. Highly targeted species, such as parrot fish, are caught between Meck and Bigej Islands to the south.

Ennylabegan Island is home to several subsistence and part-time Marshallese commercial fishermen. Fishermen from Ebeye and Kwajalein target reef species, such as rabbit fish, in this area. A species of edible crab (baru) is abundant on the nearby island of Gea, but may also be found less frequently on Ennylabegan. South Pass, south of the island, is reportedly abundant with blacktip shark. Pelagic species, such as blue marlin, can be caught off the ocean side of Ennylabegan throughout the year.

Gagan's nearshore lagoon waters are fished by Marshallese from Ennubirr in the north and Ebeye in the south. Lobster occur on the reef and targeted fish species, such as snapper, occur in Gagan's adjacent waters.

Eniwetak Island's location, inside the lagoon fronting the passage, subjects it to strong currents; therefore, it is an inconvenient and difficult landing site for fishermen. As with other channels, Eniwetak Passage affords access to the ocean with considerable trolling opportunities for pelagic species.

Illeginni Island is bordered by Onemak West Passage at its southern end. Ebeye fishermen fish in the area for reef species such as white-lined cob. Kwajalein fishermen occasionally catch pelagic species such as blue marlin outside the passage. Mullet occur along the lagoon reef flat margin and terrace at Illeginni and nearby Onemak Island.

Ebeye fishermen reportedly target 68 species of marine life in their fisheries. They catch pelagic species nearly year round off the southern end of the atoll. They also fish in Gagan's nearshore lagoon waters, near Ennylabegan, and off Illeginni for reef species such as surgeon fish and groupers.

Fish Poisoning

The marine environment has been exposed to dredging, filling, and other physical changes at Kwajalein and many other atolls in the Pacific Ocean during the past half century.

These activities have been implicated as causes for increased incidence and outbreaks of ciguatera fish poisoning that have occurred at some of the same atolls (Randall, 1980; Withers, 1982). The poisoning is caused by a toxic dinoflagellate, *Gambierdiscus toxicus*, which grows on macroscopic algae that are consumed by fish. The herbivores are eaten by carnivorous fish and the toxin is thus passed up the food chain. Although mildly toxic to fish, ciguatera is more toxic to mammals, including man (Withers, 1982). Considerable research has been done by the Japanese and French on the causes, symptoms, and distribution of ciguatera, especially in French Polynesia, where it is particularly prevalent.

Cases of ciguatera have been reported among Kwajalein residents, but these have been relatively mild, with victims often showing the more common symptoms such as tingling of the lips, mouth, and extremities, as well as hot and cold reversal. At Kwajalein Hospital, 62 cases have been treated since 1980 while at Ebeye Hospital, 221 cases have been treated since 1986. All cases at Ebeye Hospital were contracted from fish caught in Kwajalein Atoll and surrounding waters (Jerry Brackett, USAKA, personal communication, April 19, 1989). Ciguatera fish have been captured off the northern tip of Roi-Namur Island. Ciguatera outbreaks occasionally occur in areas where there have been no previous disturbances; therefore, there is no conclusive link between ciguatera poisoning and changes in the environment at USAKA.

3.7 RARE, THREATENED, OR ENDANGERED SPECIES

Biological resources discussed in this section include rare, threatened, or endangered terrestrial and marine species known to occur within Kwajalein Atoll and the surrounding ocean areas. Species discussed include sea turtles, giant clams, and seagrasses.

The region of influence for rare, threatened, or endangered species covers the entire Kwajalein Atoll environment (marine and terrestrial habitats) and the BOA north and east of the atoll.

Data sources are those of the terrestrial and marine surveys cited in other sections of this chapter, information obtained from the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, and surveys performed in other areas of the western Pacific Ocean region by the East-West Center and the South Pacific Regional Environmental Programme.

The green sea turtle (*Chelonia mydas*) is listed as a threatened species and the hawksbill turtle (*Eretmochelys imbricata*) is listed as an endangered species by the United

States. In a careful survey of the shores of the eight outer islands in March 1988, no evidence of previous nesting by green sea turtles was found by any of the biological teams; however, a few turtles were sighted in the water during the recent survey, and sea turtles are known to frequent the ocean food disposal areas in great numbers at times. Of the islands visited by the survey teams in March 1988, Ennylabegan had the best potential nesting beaches. The rising number of Marshallese inhabitants and burgeoning populations of introduced animals make it unlikely that turtles breed there successfully. Sea turtles continue to be a traditional food source for the Marshallese and RMI has not afforded the turtles endangered or threatened species status.

A green sea turtle with a 15-inch carapace was captured offshore of Gagan Island and two hawksbill turtles with carapaces about 18 inches long were seen in 1988 off the old Jackaroo Club building on Roi-Namur (Clapp, 1988). Both species were reported to be formerly much more abundant off Roi-Namur. Nesting there by the green sea turtle has been alleged, but no substantive information is available (Clapp, 1988).

Although there are five species of giant clams found throughout the Marshall Islands, the largest species (*Tridacna gigas*) has been significantly reduced in numbers throughout the Marshall Islands and has been extirpated from the Caroline Islands. The only reproductively viable population of *T. gigas* has been found off Gellinam Island (Titgen et al., 1988). Although not currently listed as an endangered or threatened species, its status is being evaluated by the RMI government and the National Marine Fisheries Service for possible classification as such. These giant clams are harvested by foreign fishermen (the muscle of the clam sells for around $100 per pound in Asian markets). The native Marshallese eat any of the giant clam species, but prefer the smaller, more common species.

A species of seagrass (*Halophila minor*) is found in the lagoon on two islands, Kwajalein and Roi-Namur (Figures 3.1-2 and 3.1-3). Previously, *Thalassia hemprichii* was the only seagrass known from the Marshall Islands (Tsuda, et al., 1977), but it is not found at USAKA. The only currently known seagrass beds identified at USAKA are *Halophila*.

As part of the coordination process required under NEPA and the Endangered Species Act, an exchange of correspondence among the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NMFS) was initiated in May 1989. Copies of the correspondence among USACE, USFWS, and NMFS are shown in the appendix to this DEIS.

3.8 ARCHAEOLOGICAL, HISTORICAL, AND CULTURAL RESOURCES

3.8.1 INTRODUCTION AND ARCHAEOLOGICAL BACKGROUND

Cultural resources consist of those material remains of human activity significant in the history, prehistory, architecture, or archaeology of the USAKA area:

- Prehistoric Resources: Those cultural resources that were produced by the preliterate, indigenous people of the USAKA area and that are of archaeological interest (e.g., the possible Marshallese gravesites on Omelek Island).

- Historic Resources: Those cultural resources or landscapes produced since the advent of written records in the USAKA area and that are of archaeological and/or historical interest (e.g., the World War II facilities on Roi-Namur Island that are included in the National Register of Historic Places).

Eastern Micronesia, including the central and eastern Caroline Islands, the Marshall Islands, and Kiribati (Gilbert Islands), was probably settled initially by northern migration from the Vanuatu-Banks Islands of Melanesia. This assumption is based on ethnolinguistic correlations. Human settlement appears to have occurred at least as early as the first millennium BC and may have occurred as early as 1500 BC in the Marshall Islands (Dye, 1987; Streck, 1987). A range of archaeological sites have been identified as indicative of long-term prehistoric Marshallese settlement on the atolls of the archipelago. These sites include elaborate fishtraps, coral and/or beachrock slab gravesites, wall alignments, coral pebble pavements, coral chunk platforms, artifact and midden scatters, earthen cooking ovens, raised or lined pathways, fortifications, and stratified cultural deposits.

Archaeological surveys within the USAKA portion of Kwajalein Atoll have included subsurface auger sampling along the eastern end of the original Kwajalein Island (Watanabe, 1986); inspection of several construction sites near the Bucholz Airfield terminal (Streck, 1987d); construction monitoring and test excavation for the reconstruction of the airfield taxiway and parking apron on Kwajalein Island (Shun and Athens, 1987); and reconnaissance survey and testing on Legan Island (Streck, 1986b). Potentially significant cultural remains (prehistoric cultural and midden deposits, traditional artifacts, probable house pavements, and surface structures) were identified during all these surveys, including evidence of human habitation on Kwajalein Atoll for at least 2,000 to 2,500 years. Indigenous traditional Marshallese artifacts (e.g., Tridacna and Conus spp. adzes,

shell bracelets, shell fishhooks) were recovered from both Legan and Kwajalein Islands, as well as World War II remains. Most of the prehistoric/traditional Marshallese cultural remains consist of midden deposits with associated functional features situated toward the center of the original island surface.

The most recent archaeological study to be performed within USAKA was a reconnaissance survey on all eleven islands in 1988 (Schilz, 1989). Because most previous research had been performed on Kwajalein Island, this 1988 survey was concentrated on the other USAKA islands. Investigations on Roi-Namur were limited to inspecting exposed erosional scarps and recording Japanese World War II structures because of the likelihood of encountering live ordnance during subsurface testing. Indigenous Marshallese cultural remains (e.g., portable artifacts, structures, functional features, midden deposits) radiocarbon-dated to as early as 1000 AD were found on five islands: Eniwetak, Ennugarret, Ennylabegan, Legan, and Omelek. The spatial distribution of identified archaeological resources within USAKA is probably the result of both extensive modern disturbance to island surfaces and traditional Marshallese settlement preferences. A possible marker for the presence of subsurface cultural deposits is the presence of mature stands of native vegetation. For example, the archaeological resources identified on Legan and Eniwetak are situated within stands of Pisonia sp. trees. These areas have had less modern disturbance than island areas that do not contain this tree species. These forests tend to be located towards the center of islands where more natural protection from severe climatic events would make them desirable for domestic habitation.

In addition to the studies performed with USAKA, there has been one additional archaeological survey on Kwajalein Atoll consisting of a reconnaissance of six islets north of Ebeye (south Loi to Ningi) in 1984 (Athens, 1984). Indigenous Marshallese artifacts (shell adzes) were found on Ningi and Japanese World War II structures on Ebioaji Island.

Cumulatively, archaeological research on Kwajalein Atoll and elsewhere in the Marshall Islands suggests that many of the prehistoric remains within USAKA may be of high significance. These prehistoric remains may provide data that can be used to determine and explain factors relevant to initial settlement, duration of residence, settlement pattern, and cultural evolution. This significance is enhanced because of the absence of systematic archaeological research elsewhere on Kwajalein Atoll.

Kwajalein appears to have been settled by a people who professed a distinctive Micronesian material culture by at least the first millennium BC (Shun and Athens, 1987). Long-term settlement appears to have been maintained for

hundreds or thousands of years on the larger islands and possibly on some smaller islands. The material cultural remains suggest that some degree of social stratification was present from the earliest settlement. In addition, the full range of available environmental resources from taro cultivation to marine resource harvesting and hunting was employed.

Historic-Era Background

Relatively little is known of the pre-Japanese-era history of Kwajalein Atoll (pre-1914 AD). Kwajalein Atoll was probably sighted, but not contacted, by the Spanish explorers de Villalobos in 1542 and de Arellano in 1565 (Hezel, 1979). A British captain, John Mertho, is officially credited with discovering the atoll in 1804 (Hezel, 1983) calling it Catherine Island.

Starting in about the 1830s, American and European whaling vessels ventured into this portion of the Pacific Ocean and often stopped at various atolls for rest and provision. Encounters with native populations were often hostile and the Marshallese gained a reputation for ferocity. Kwajalein Atoll is cited as being the scene for the massacre of two passengers of the British ship William Melville in 1850 and of the forcible boarding of an unnamed whaleship by 60 canoe-loads of Marshallese in 1862 (Hezel, 1979).

Except for these events, Kwajalein Atoll does not figure as a prominent Marshallese location but rather as a virtual backwater during the German colonial era from 1885 to 1914 (Athens, 1984; Shun and Athens, 1987). The Germans did establish copra plantations and trading stations, as at other Marshallese atolls (Hezel, 1987). Although Christian missions to the Marshall Islands began in 1857 (on Ebon), a preaching station, including a church, was not established on Kwajalein until 1892; it functioned until 1941 (Schilz, 1989).

The Japanese took over administration of most of Micronesia, including the Marshall Islands, in 1914, shortly after the outbreak of World War I. After the war, the League of Nations mandated the Marshall and other Micronesian islands to Japan. In 1935, Japan began to fortify the Marshall Islands. Kwajalein Atoll became the headquarters for the Japanese 6th Base Force and Fourth Fleet with principal military installations on Kwajalein and Roi-Namur Islands by 1943 (Bell Telephone Laboratories, 1974). The atoll, and Kwajalein Island in particular, was turned by the Japanese into a stronghold through which shipping, supplies, and reinforcements flowed to the other Marshall Islands atolls.

Kwajalein Island contained communication and weather observation units and an airstrip. A seaplane base was situated

at Ebeye and a major airstrip and submarine base were housed at Roi, with other installations scattered on various islands throughout the atoll. Admiral Nimitz, Commander of the U.S. Pacific Fleet, chose Roi-Namur and Kwajalein Islands as primary targets in the U.S. invasion of the Marshall Islands (Schilz, 1989). Kwajalein Atoll was the scene of fierce World War II fighting in January 1944 during the American invasion, "Operation Flintlock." The atoll, and particularly Roi-Namur and Kwajalein Islands, were subjected to severe air, land, and sea bombardment. Hand-to-hand combat between elements of the U.S. Army and Marines and Japanese defenders resulted in a U.S. victory (Bell Telephone Laboratories, 1974; Crowel and Love, 1955; Morison, 1951; Thompson, 1984a, 1984b; Denfeld, 1980).

Since World War II, portions of Kwajalein Atoll have been continuously used for military purposes by the U.S. Government. It was first a refueling and communications base, subsequently a support facility for the testing of nuclear weapons on Bikini and Eniwetak Atolls, and later a test site for the Nike-Zeus Anti-Missile Program. After several changes in command, the Kwajalein Missile Range (KMR), since renamed U.S. Army Kwajalein Atoll (USAKA), was designated for testing of guided and ballistic missiles. Eleven of the atoll islands are leased by USAKA, including Kwajalein Island, which is the headquarters and residence for most of the American personnel.

All of both Roi-Namur and Kwajalein Islands were nominated to the National Register of Historic Places in 1984 and have since been designated the Roi-Namur Battlefield National Landmark and the Kwajalein Island Battlefield National Landmark because of the pivotal importance of American victories at these sites towards resolving World War II. Only a few Japanese structures, mostly concrete bunkers, are extant on Kwajalein Island because of massive modern development. The surviving structural remains on Roi-Namur, however, are representative of a wide range of Japanese World War II activities including the command post, ordnance and machine gun bunkers, artillery posts, hospital, and support facilities. None of the other islands contained within USAKA have been nominated nor considered for inclusion to the National Register. A potential historical resource that has not been evaluated is that which is represented by World War II-era warships sunk in Kwajalein lagoon.

3.8.2 KWAJALEIN ISLAND

Archaeological investigations on Kwajalein Island have identified subsurface prehistoric and historic remains in dispersed areas correlating with the original island surface. (Kwajalein has been almost doubled in size as a result of landfilling during the mid-to-late twentieth century.) These include possible prehistoric cultural

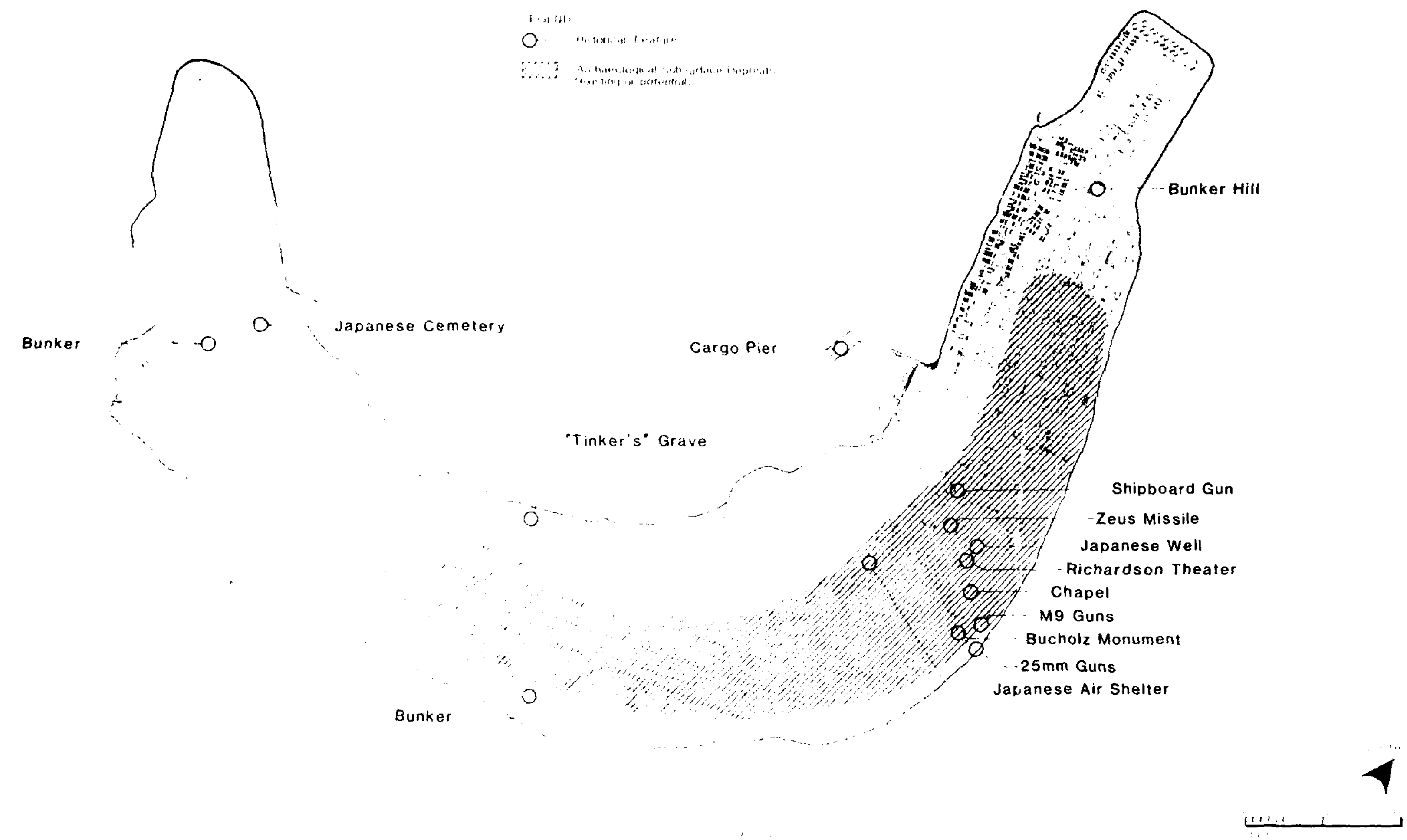
sediments that range from dark gray to black in the northern portion of the island, within present family housing quarters; discontinuous prehistoric cultural deposits beneath the present airfield taxiway containing charcoal, marine shell and fauna midden, ornamental and utilitarian shell artifacts, and housesite remains radiocarbon-dated at 2,000 to 2,500 years ago; and World War II-era remains from Japanese defensive bunkers and a potable water system. There are also probable prehistoric sediments in the central portion of the island near the airfield terminal (Figure 3.8-1).

Archaeological sedimentary and pollen analyses suggest that the original center of Kwajalein Island may have contained a freshwater swamp/marsh that would have been ideal for the traditional cultivation of taro, a Marshallese staple. Few surface structures from the Japanese era remain because of modern development. The most notable are the remains of a large bunker situated within the family housing area and a cemetery at the western end of the island in which Japanese World War II remains are interred.

These archaeological investigations suggest that there is a high probability for discontinuous, intact prehistoric and/or historic era sedimentary/cultural deposits and remains throughout those portions of Kwajalein Island corresponding to the original island shape. A layer of dredged fill approximately 1 meter deep covers most of the surface.

3.8.3 ROI-NAMUR ISLAND

Disturbance to the island has been substantial since the 1930s. The single island of Roi-Namur that exists now has been formed through creating fill land to link the original islands of Roi and Namur, and a small islet once situated between them, and expanding other shoreline areas. These operations were initiated during the Japanese mandate and have continued through American use of the island. The bombardment that accompanied the U.S. invasion in 1944 and subsequent establishment of residential and technical facilities have left little, if any, of the original island surface intact (Figure 3.8-2). The presence of intact prehistoric cultural deposits in original island areas cannot be entirely discounted for there has been no systematic archaeological testing. Testing has been discouraged because of the presence of live ordnance. Forty-eight Japanese structures have been identified (Thompson, 1984b; Schilz, 1989). These structures are in highly variable states of preservation that range from largely intact to highly weathered or eroded.

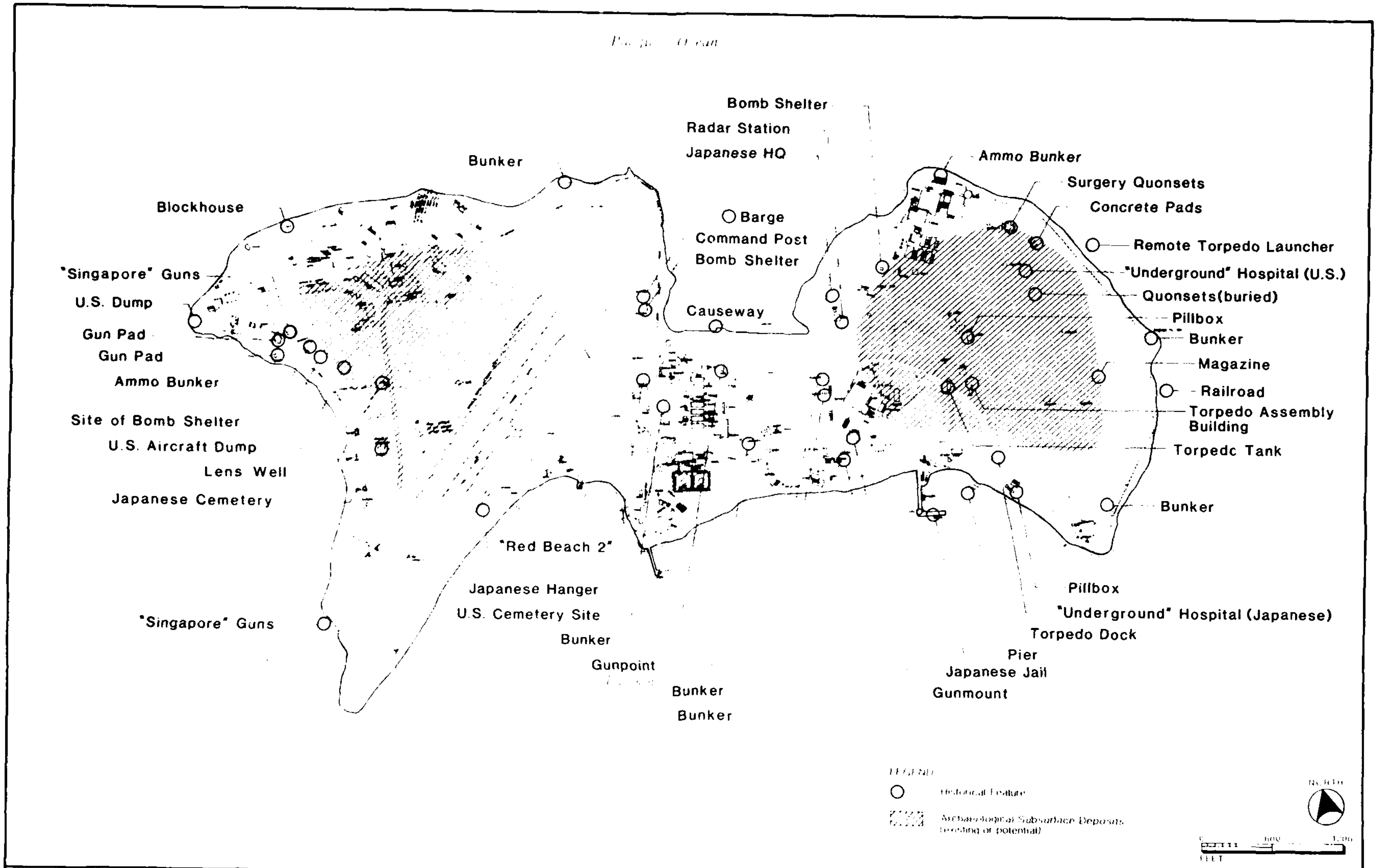


U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ARCHAEOLOGICAL AND HISTORICAL RESOURCES

KWAJALEIN ISLAND

Figure 3.8-1



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ARCHAEOLOGICAL AND HISTORICAL RESOURCES

ROI-NAMUR ISLAND

Figure 3.8-2

3.8.4 ENNYLABEGAN ISLAND

This island was completely surveyed and tested archaeologically in 1988 (Schilz, 1989). Several areas containing possible historic, modern-era sites (e.g., a cemetery and Japanese World War II structures) as well as traditional Marshallese cultural remains (stacked coral wall alignments and surface artifacts) are situated outside the boundary of the existing USAKA facility. A cluster of Japanese and possible American era concrete structures are present within the USAKA facility and adjacent Marshallese village. Although no definitive evidence for the presence of subsurface cultural deposits was found during the 1988 survey, a small forested area in the center of the USAKA facility contained probably sparse midden remains and charcoal (Streck, 1988, personal observation). This may represent portions of a thin cultural deposit, perhaps only discontinuously intact and similar to that from which traditional Marshallese shell adzes were derived in the southern portion of the island.

3.8.5 LEGAN ISLAND

Archaeological reconnaissance (Streck, 1987b) and intensive survey (Schilz, 1989) has been performed on Legan. Intact surface and subsurface cultural remains were identified in the northern portion of the island in direct association with a predominantly *Pisonia*-*Cocos*-*Pandanus* forest (Figure 3.1-6). Thick midden deposits (45-80 centimeters), discontinuously present because of modern disturbance, were identified as well as the surface collection of traditional Marshallese artifacts (pearlshell fishhook, *Tridacna* sp. adzes, and a wooden *Pandanus* sp. pounder). Legan appears to have hosted a domestic habitation site continuously occupied from about the sixth or seventh through nineteenth centuries AD. This archaeological site is also significant because it contains the most extensive traditional Marshallese surface structural remains of any of the islands within USAKA, including a large possible coral pebble/cobble house platform, low discontinuous wall alignments, a small high platform, and possible gardening areas.

3.8.6 GAGAN ISLAND

Most of Gagan Island has been affected through construction of the current installation, which covers approximately 75 to 80 percent of the island. The entire land surface appears to have been bulldozed flat and then rolled. No evidence of Marshallese occupation was found during archaeological survey of the entire island (Schilz, 1989). A single Japanese concrete pillbox is situated at the northernmost end of the island facing eastward across the reef toward the open ocean.

3.8.7 OMELEK ISLAND

Omelek has been completely disturbed along the eastern (seaward) side through construction of buildings and a helipad. It has been somewhat less disturbed in the central and southern portions. Archaeological pedestrian survey and subsurface testing has been performed on the island (Schilz, 1989). One archaeological site is situated in a small stand of native vegetation north of the jetty and boat ramp along the western (lagoon) shoreline (Figure 3.1-10). This site consists of the probably partially disturbed remains of a traditional Marshallese cemetery in which coral and/or beachrock slabs have been used for constructing burial crypts. It is highly likely that intact subsurface cultural deposits, as well as possible burial remains, are present within this area.

3.8.8 ENIWETAK ISLAND

Archaeological reconnaissance survey of the island was performed in 1988 (Schilz, 1989). Inspection of machinery cuts that resulted from routine maintenance activities along the edge of the *Pisonia sp*. forest, which covers much of the island, suggested the presence of cultural deposits. Controlled archaeological test excavations determined that a thick (70 to 80 centimeters) stratified cultural deposit was present (Figure 3.1-11). Numerous functional features, mostly from earthen cooking ovens or firepits, were associated with this deposit as well as marine mollusk shell and fish bone midden. Radiocarbon-dating of charcoal samples suggest that Eniwetak may have been occupied for a relatively short period from about 1000 to 1300 AD.

3.8.9 ENNUGARRET ISLAND

All of this island was archaeologically reconnaissance surveyed (Schilz, 1989). No intact World War II structural remains are present although there is dense debris in portions of the island. A single archaeological site consisting of a wave-cut exposure with charcoal-rich, dark-colored sand lenses a few centimeters thick is present on the southeast shoreline. Radiocarbon-dating of charcoals from these lenses suggest that Ennugarret may have been prehistorically inhabited during the thirteenth through fifteenth centuries AD.

3.8.10 OTHER ISLANDS

Disturbance to Meck Island is nearly complete through construction of major launch facilities that virtually cover the entire island. No evidence for any surface nor subsurface cultural remains was found during archaeological survey of the entire island (Schilz, 1989).

No indigenous cultural remains were identified on Illeginni Island during archaeological survey and testing of the entire island (Schilz, 1989). Most or all of the island surface has been bulldozed.

Impacts from previous development activities are also extensive on Gellinam Island. Most of the island has been bulldozed and vegetative cover is minimal. No cultural resources were identified during survey and testing of the entire island (Schilz, 1989).

3.9 LAND USE

This section summarizes the spatial characteristics and interrelationships of the USAKA environmental resources and installation facilities, and describes USAKA's land use plans and policies. Numerous Army and Department of Defense regulations, guidelines, and criteria guide facility planning and operations at USAKA. These include the USAKA Master Plan Report, which describes future development scenarios and requirements at USAKA (USAKA, 1988).

The region of influence is the USAKA islands. Land use in the remaining islands in the Kwajalein Atoll is beyond the direct or indirect influence of either the U.S. government or USAKA.

ANALYSIS OF EXISTING CONDITIONS

The principal patterns of land use for Kwajalein, Roi-Namur, and Meck Islands are depicted in the accompanying land use and facilities maps (see Figures 3.9-1 to 3.9-3). Land use patterns for other USAKA islands are illustrated in color photographs at the end of this section (Figures 3.9-4 through 3.9-12).

Kwajalein Island

As depicted in Figure 3.9-1, Kwajalein, with a land area of approximately 748 acres, has a land use pattern that locates housing and most community facilities toward the eastern end of the island; air operations are in the center, and research, development, and communications operations are toward the western end of the island. Structures are set back from the ocean side of the island in order to minimize the potential adverse effects of high wave action.

Land use categories, in approximate descending order of proportional area, consist of: flight operations; family housing; research and development (R&D) (operations and supply); communications operations; supply (which includes supply, high explosives magazine, petroleum oil lubricant

(POL), and disposal); community support and unaccompanied personnel housing (UPH); outdoor recreation; utilities; maintenance; sanitary landfill; waterfront operations; and administration.

Land use, including the siting, heights, and setbacks of buildings, is accommodated to air safety and noise constraints relative to the airfield, explosive (storage and handling) safety quantity distances (ESQD), and electromagnetic radiation (EMR) safety zones surrounding radars, radio antennas, and microwave emitters. Further details on safety considerations are discussed in Section 3.14 of this DEIS.

Roi-Namur Island

Roi-Namur, with a land area of approximately 398 acres, has a land use pattern (Figure 3.9-2) that generally reflects a distinct separation of community and support facilities on one side of the airfield runway from flight operations and radar and technical operations on the other side of the island. Exceptions are the community facilities, located in the multi-purpose airport building, which is also the USAKA/Pan Am administrative center, and the R&D operations and rocket launching facilities located in the north central area, approximately 1,000 feet west of the community support and housing hub.

In descending order of proportional area, the predominant land uses are R&D operations, flight operations, outdoor recreation, community support/UPH, maintenance, utilities, high-explosive supply, supply, base support, and administration.

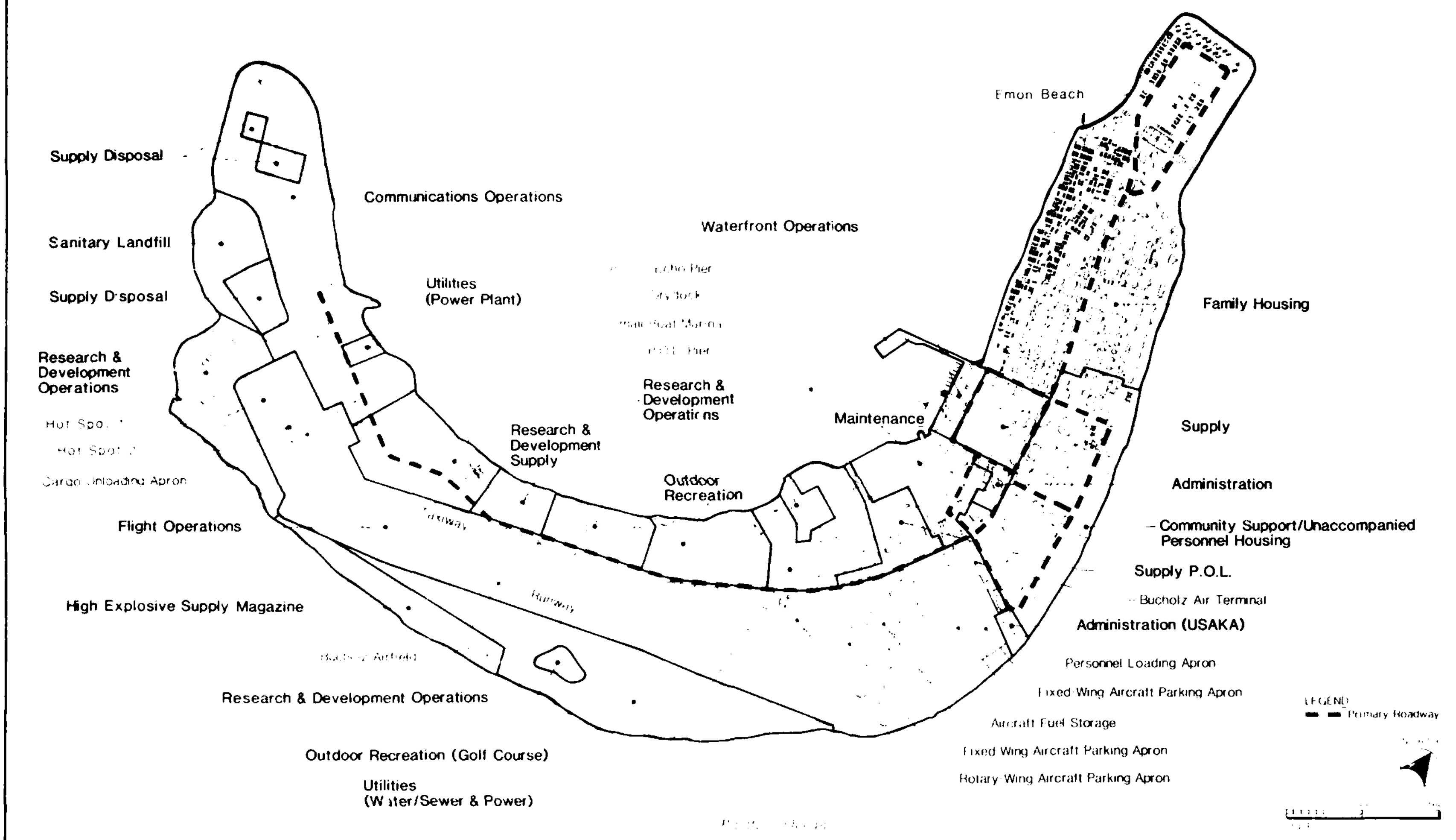
As on Kwajalein Island, Roi-Namur's land use pattern accommodates to air safety and noise standards, explosive safety distance standards, and electromagnetic radiation safety zones.

Meck Island

Meck, totalling 55 acres, has been substantially transformed from its natural condition and has been increased by about 14 acres of filled land (Figures 3.9-3 and 3.9-8). In the southern half of the island are facilities related to power generation, maintenance and supply, waterfront and air operations, and limited community support facilities. The central and northern half of the island consists of R&D operations that include missile launch complexes.

Omelek Island

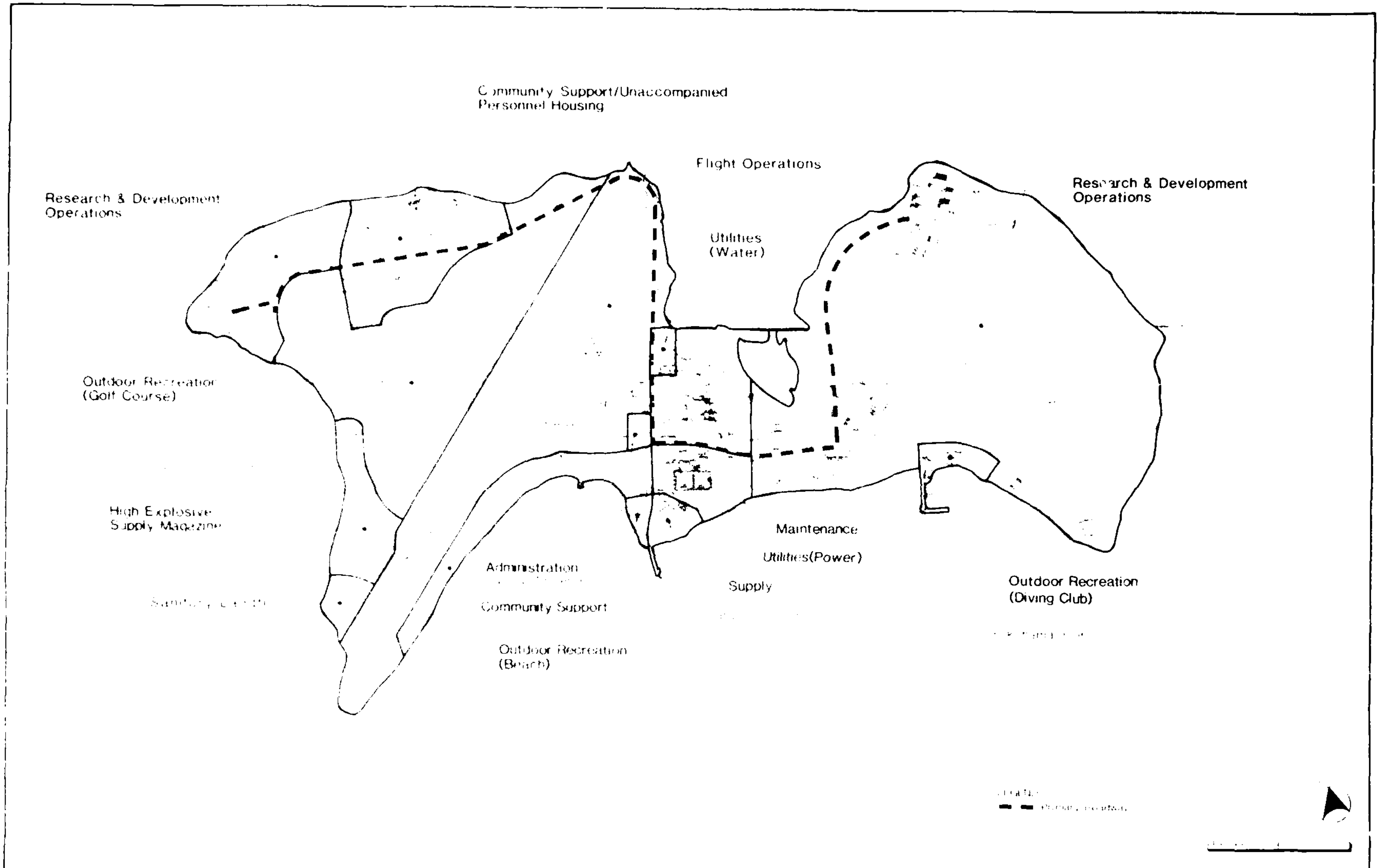
Omelek is an 8-acre island with facilities for R&D operations, including a meteorological rocket launch facility. It contains three small forested areas (Figure 3.9-9).



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND USE AND TRANSPORTATION
KWAJALEIN ISLAND

Figure 3.9-1



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LAND USE AND TRANSPORTATION

ROI-NAMUR ISLAND

Figure 3.9-2

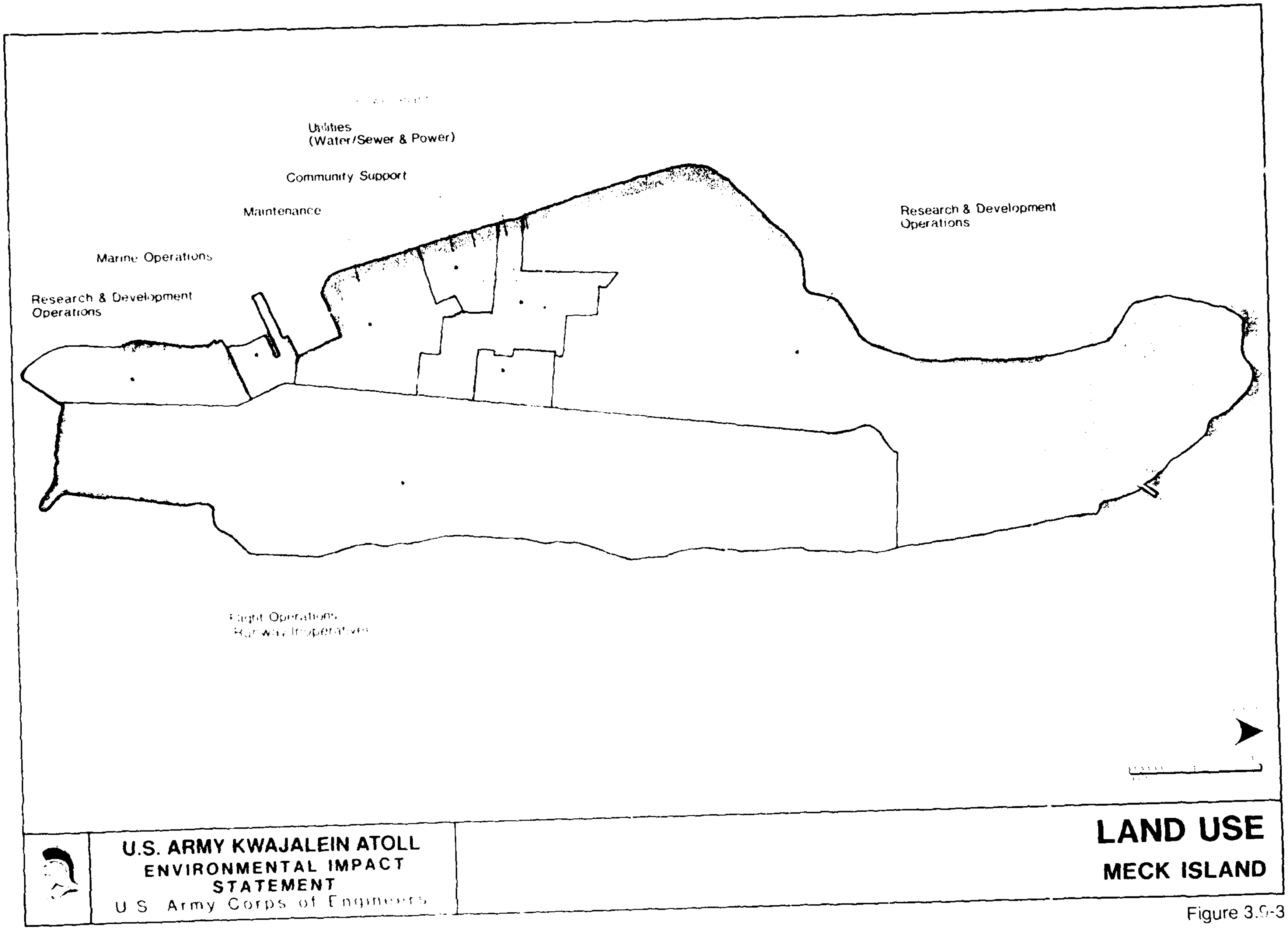
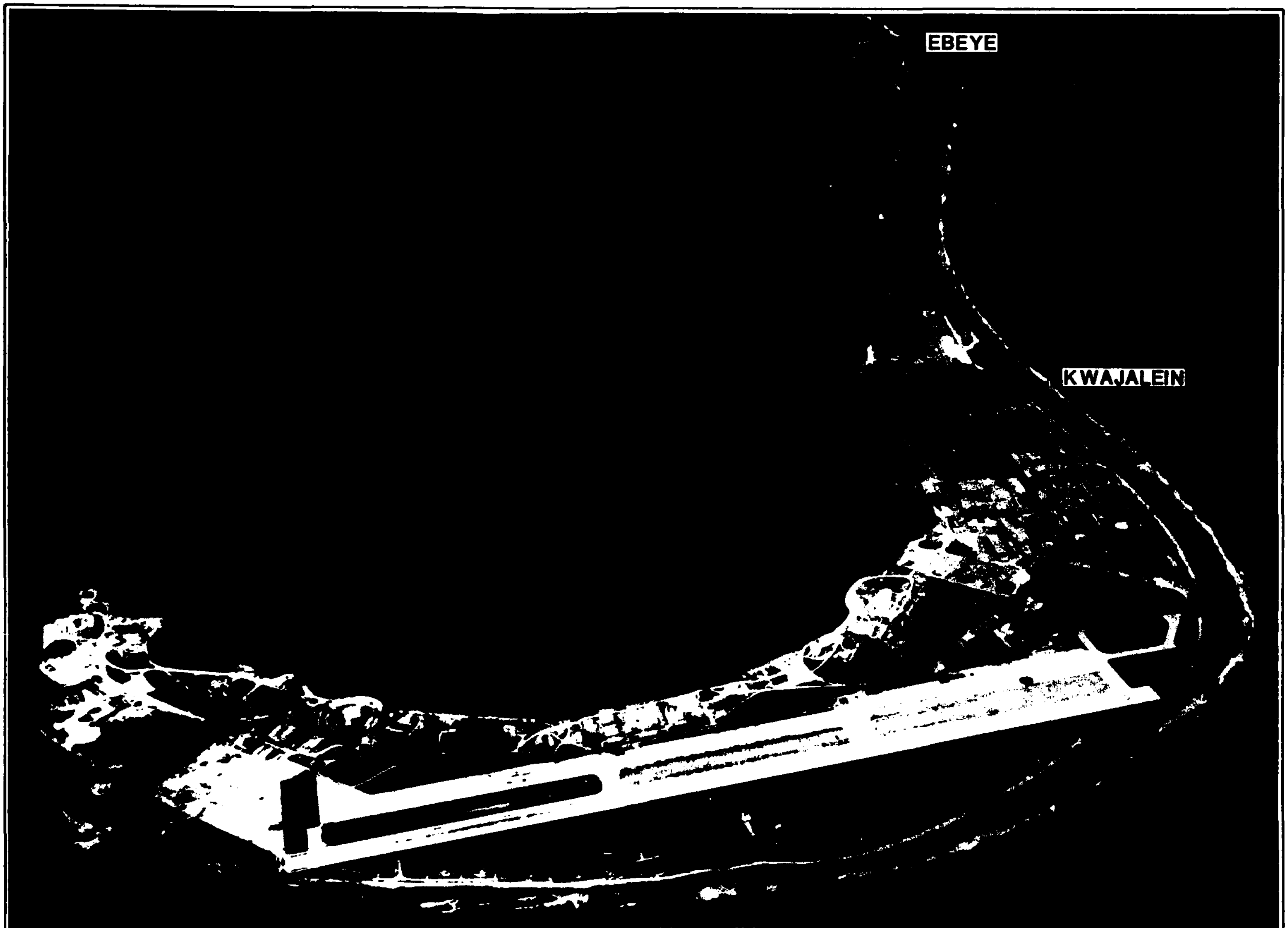

Utilities
(Water/Sewer & Power)
Community Support
Maintenance
Marine Operations
Research & Development
Operations
Research & Development
Operations
Flight Operations
Runway Inoperative
U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT
STATEMENT
U S Army Corps of Engineers
LAND USE
MECK ISLAND

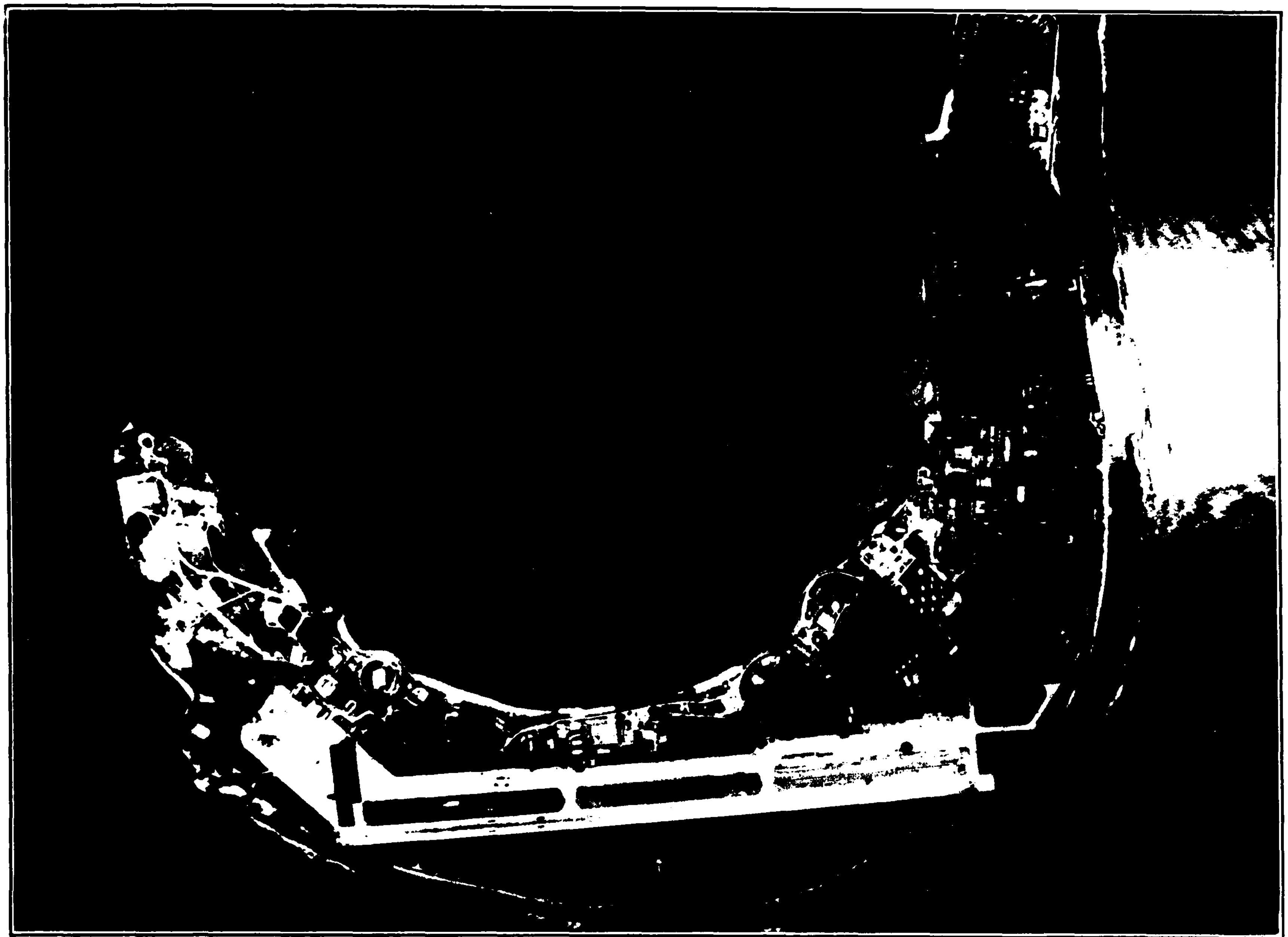
Figure 3.9-3



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U S Army Corps of Engineers

KWAJALEIN ISLAND

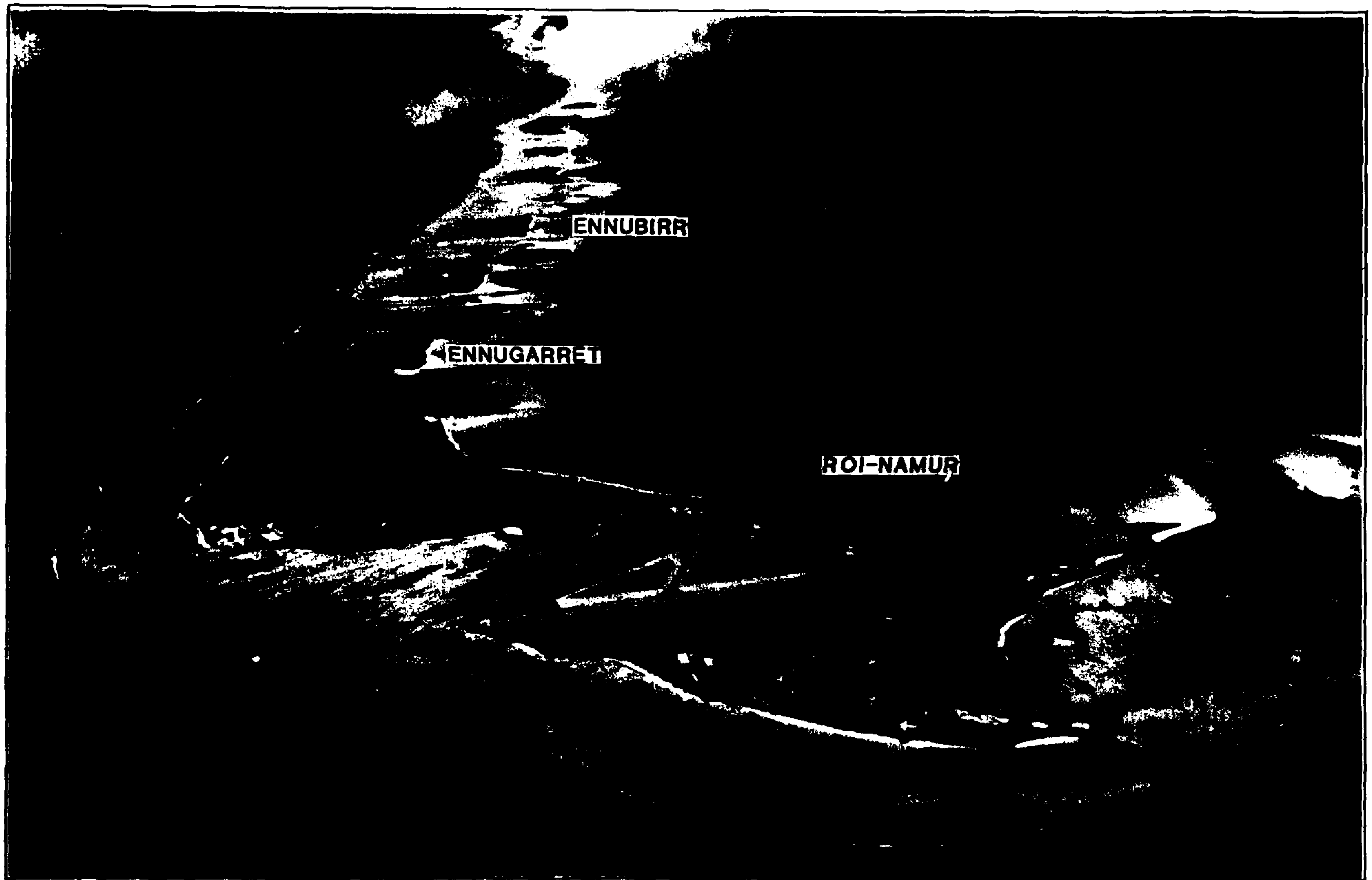
Figure 3.9-4



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U S Army Corps of Engineers

KWAJALEIN ISLAND

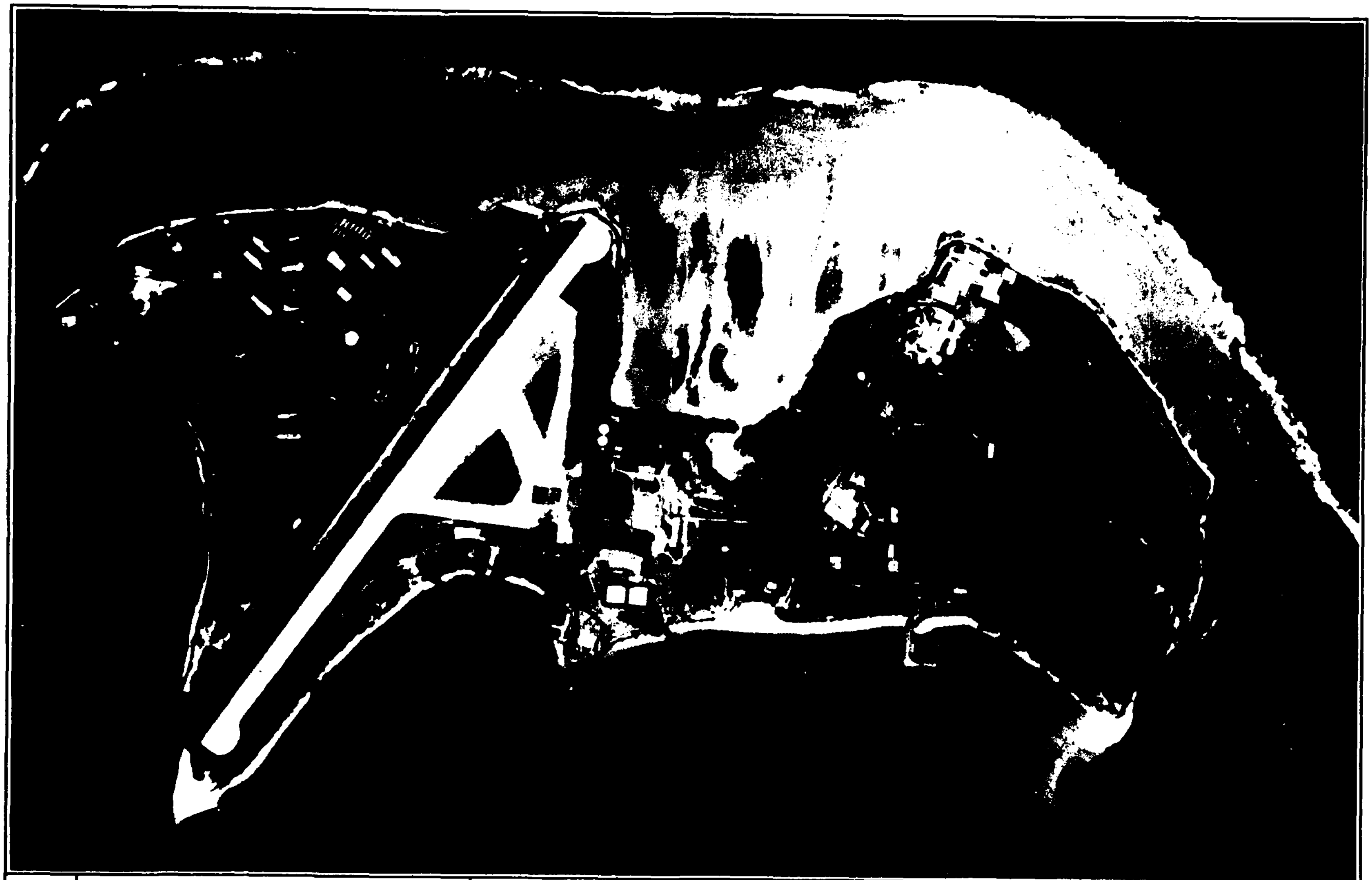
Figure 3.9-5



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ROI-NAMUR ISLAND

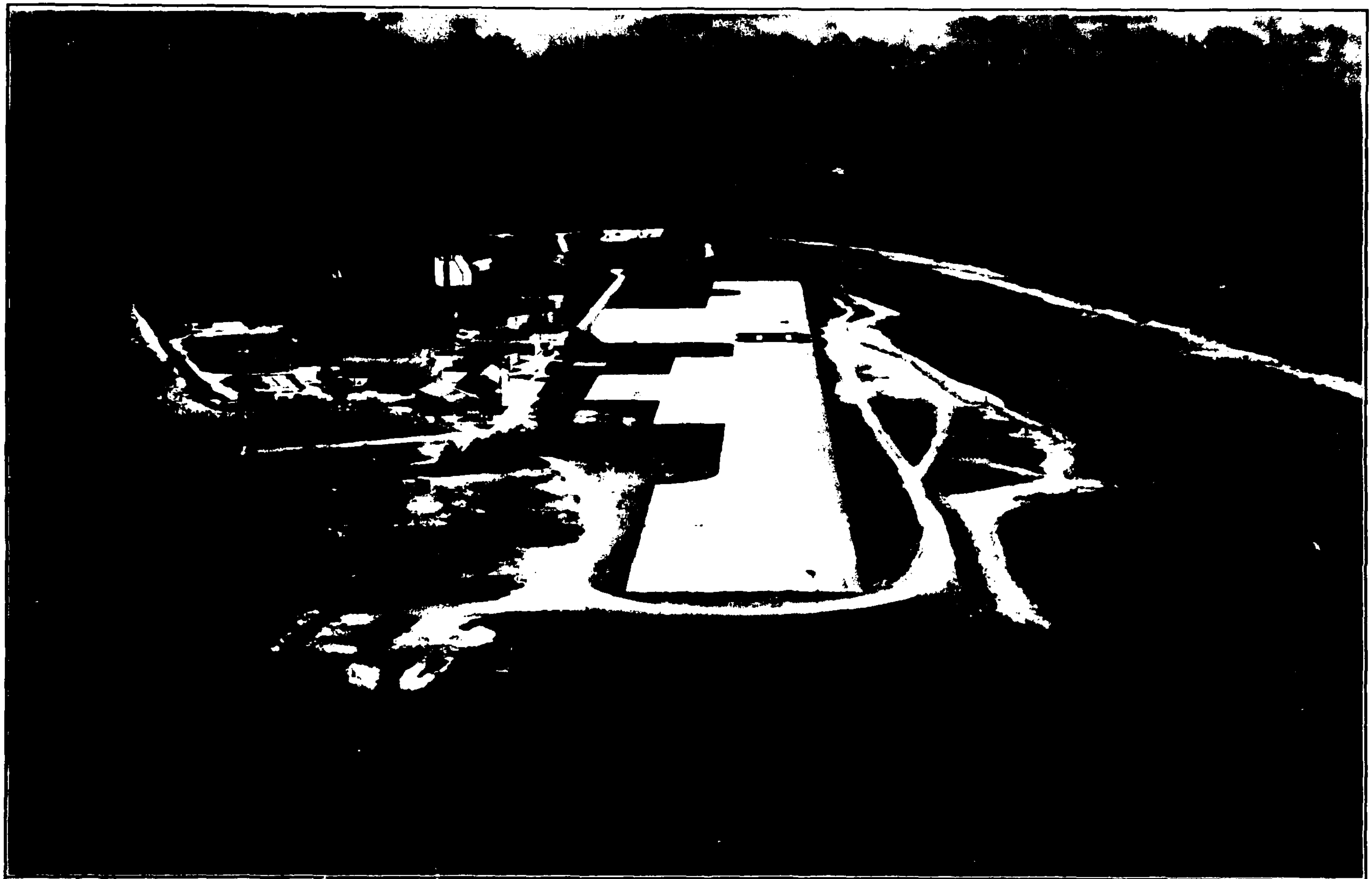
Figure 3.9-6



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ROI-NAMUR ISLAND

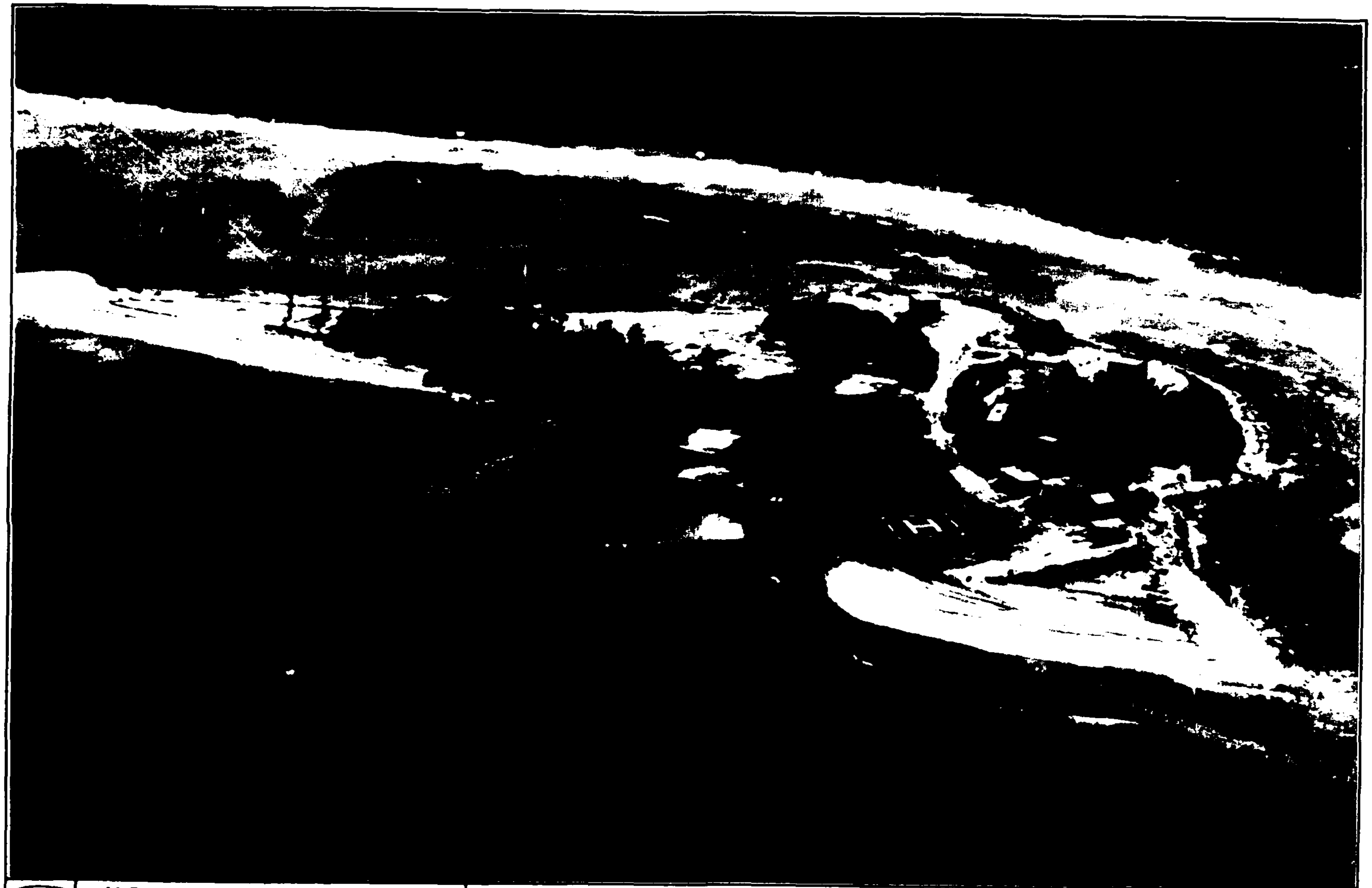
Figure 3.9-7



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

MECK ISLAND

Figure 3.9-8



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

OMELEK ISLAND

Figure 3.9-9

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ENNYLABEGAN ISLAND

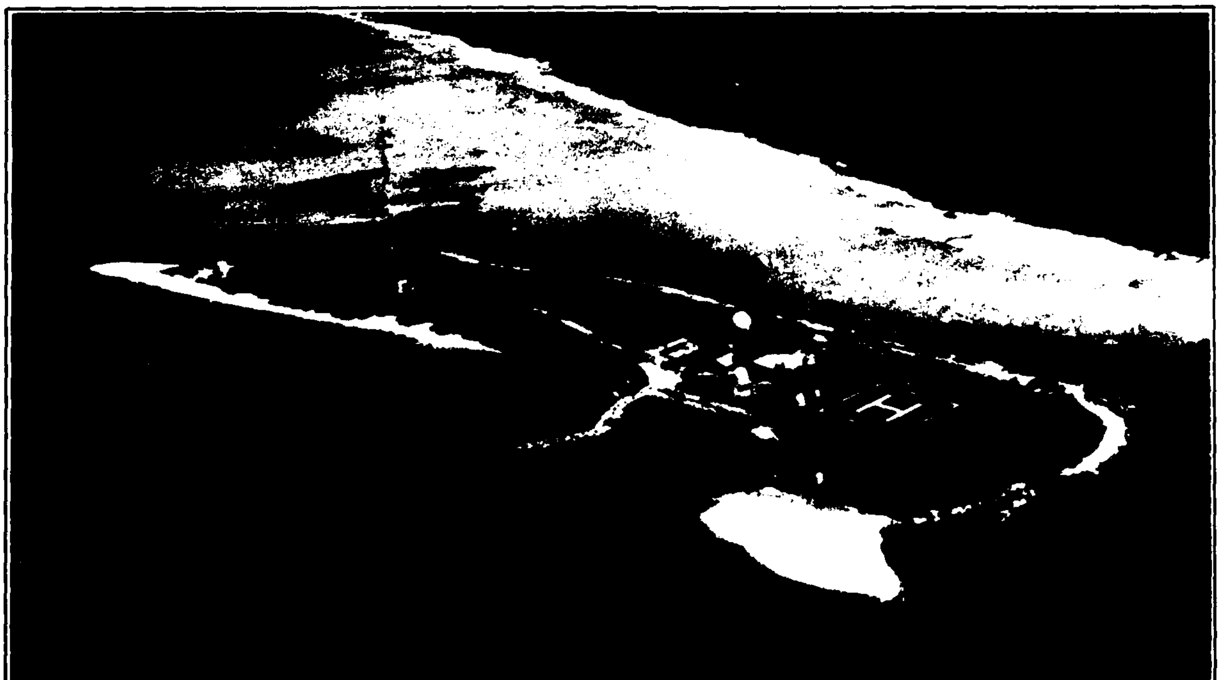
U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LEGAN ISLAND

Figure 3.9-10

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

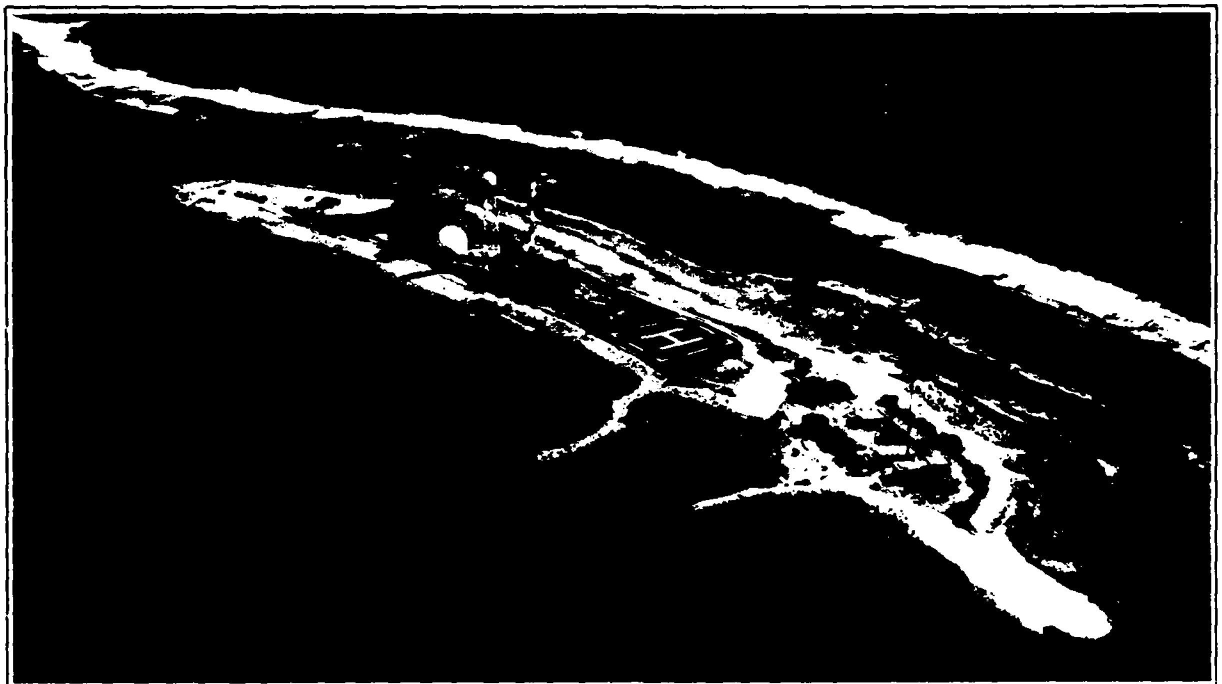
ILLEGINNI ISLAND



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

GAGAN ISLAND

Figure 3.9-11



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ENVIRONMENTAL IMPACT STATEMENT
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GELLINAM ISLAND

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ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ENIWETAK ISLAND

Figure 3.9-12

Other USAKA Islands

All of the remaining USAKA islands were modified to various degrees prior to 1980 and are used today for various range operations. They are described elsewhere in the DEIS under the various biological and physical environment sections. Photographs on the following pages illustrate the current land uses on those islands.

3.10 SOCIOECONOMIC CONDITIONS

This section describes employment, population, housing, income, fiscal conditions, recreation, education, and health care.

The socioeconomic region of influence is defined primarily as the islands of USAKA and secondarily as the islands of Ebeye and Ennubirr (where most of the Marshallese who work at USAKA reside).

Data were collected by the U.S. Army Corps of Engineers and CH2M HILL between September 1988 and February 1989, during which site visits were made to Kwajalein, Ebeye, Roi-Namur, and Ennubirr Islands. Additionally, interviews were conducted with USAKA, Pan Am and other contractor officials, and with Marshallese citizens and officials. Population data were derived from U.S. census reports and the November 1988 RMI census.

3.10.1 EMPLOYMENT

Employment at USAKA is the primary economic activity in the Kwajalein Atoll. Other factors that influence the atoll's economic development are direct payments to landowners and funds allocated to the Kwajalein Atoll Development Authority (KADA) (see Subsection 3.10.4). Notwithstanding fluctuations, employment at USAKA provides a relatively stable long-term economic base for both the atoll and RMI.

USAKA

USAKA's nonindigenous (primarily American) labor force comprises military personnel, federal civil service employees, and individuals recruited off-island and employed by USAKA contractors. Spouses of accompanied personnel make up a second element of USAKA's nonindigenous labor force. They are hired on-island to fill both full- and part-time jobs.

In December 1988, nonindigenous employment totaled 1,892, which is composed of 1,503 operations personnel, an average daily transient personnel population of 22, and 367 construction personnel. The operations employees included 40 military, 84 federal civil service, and 1,379 civilian

contract personnel. In addition, USAKA estimates that about 70 percent of the 550 spouses (or about 365 spouses) are employed by contractors on a full- or part-time basis. The principal contractors for operations are Pan Am World Services, Inc., 943 employees; General Electric, 180; GTE, 93; SLEC, 90; MIT/Lincoln Laboratories, 35; AEROMET, 12; and "others," with 26 employees.

Ebeye and Ennubirr

Table 3.10-1 depicts historical trends of Marshallese employment at Kwajalein Atoll. In December 1988, 1,007 Marshallese were employed at USAKA, all in positions that do not require security clearance. These included 729 operations personnel employed in base support functions, 62 domestics under personal service contracts with individual residents of USAKA, 183 construction workers, and 33 U.S. Job Corps trainees.

The historical employment data in Table 3.10-1 indicate that exclusive of domestic services, Marshallese employment at USAKA was relatively stable from 1963 to 1985-86, despite the decline in nonindigenous personnel during the same period. Since the implementation of the Compact of Free Association in October 1986, efforts by USAKA, RMI, and KALGOV officials have increased the number of jobs available for Marshallese employees (with the exception of the base support contractor) from 12 in 1985 to 289 in 1988.

In 1988, USAKA employment (including domestics) represented 52 percent of Marshallese employment at Kwajalein Atoll (USAKA data and RMI 1988 census data). For Ennubirr residents, USAKA construction activity at Roi-Namur is virtually the sole source of employment (Hobson, personal communication).

Table 3.10-2 summarizes data from an April 1989 interim report of the 1988 RMI census. The table indicates that the median age of Marshallese residents of Kwajalein Atoll is slightly less than 15 years of age.

Table 3.10-3 is an estimate of the number of Kwajalein Atoll Marshallese who are potential employees. The estimate suggests that 684 individuals (331 unemployed and 353 economically inactive) would be available to fill any new positions that might open at USAKA. The economically inactive category includes students and homemakers.

The potential for in-migration attributable to employment of Marshallese personnel at USAKA is governed by KALGOV's Ordinance No. 1986-18, enacted in April 1988 and titled "The Kwajalein Missile Range Employment Requirement Ordinance of 1986." Section 3 of the ordinance requires that only people who are of Marshallese descent or U.S. citizens married to

Table 3.10-1
HISTORICAL TRENDS OF MARSHALLESE EMPLOYMENT AT KWAJALEIN ATOLL

Employer	1963[a]	1973[b]	1980	1982[c]	1985[d]	1988
USAKA						
USAKA contractor employees	552	500	567[e]	621	532	945[d]
Personal Service Contracts (Domestics)	158	200	0	0	0	62[d]
Subtotal	710	700	567	621	532	1,007
Non-USAKA						
RMI/local government	101	256	493	265	ND	436[f]
Private sector	52	200	ND	110	ND	408[f]
Other (self-employed and unpaid family workers)	ND	ND	ND	ND	ND	92[f]
Total	863	1,156	1,060[g]	996	ND	1,943[f]

Sources:
[a]Hawaii Architects & Engineers, Inc., 1968a.
[b]TTPI, 1978.
[c]RMI, Office of Planning & Statistics, 1987b.
[d]Hobson, Victor, Jr., December 14, 1988.
[e]U.S. Department of Defense, Office of Economic Adjustment.
[f]RMI. April 1989.
[g]RMI, Office of Planning and Statistics, 1987a.

ND = no data.

Table 3.10-2
EMPLOYMENT AND RELEVANT DEMOGRAPHIC DATA
FOR MARSHALLESE RESIDING AT KWAJALEIN ATOLL

Resident population[a]	9,311
Working age population (15 years of age and older[b]	4,529
Working age population as a percent of total population	49%
Economically active[c]	2,274
Employed	1,943
Employed as a percent of economically active	85%
Unemployed	331
Unemployed as a percent of economically active	15%
Economically inactive	2,218
Homemaker	1,645
Student	390
Too old to work	161
Disabled person	22
Age of population	
Below 15 years of age	51%
65 years of age and older	2%

[a]Excludes nonindigenous population on Kwajalein and Roi-Namur Islands.
[b]The sum of the economically active and inactive does not equal the working population. The difference is attributable to 37 people who did not supply a response.
[c]The employed plus the unemployed, with the latter including persons actively seeking work and persons who are not seeking work but are available for work.

Source: RMI, April 1989.

Table 3.10-3
CURRENT AND POTENTIAL MARSHALLESE
LABOR FORCE RESIDING AT THE KWAJALEIN ATOLL

Unemployed[a]		331
Potentially economically active, based on 58 percent of working age population (15 years of age or older)[b]	2,627	
Less individuals who are currently economically active[a]	2,274	
Potential increase of economically active[c]		353
Total		684

[a] RMI, April 1989.
[b] The 58 percent rate is used by RMI for economic development planning purposes (Final Overall Economic Development Plan: Fiscal Years 1989-91. RMI. January 1989).
[c] Includes students who will eventually enter the labor force and homemakers who may choose to enter the labor force.

Marshallese citizens and who have been residents of the Kwajalein Atoll for a minimum of 2 years may be employed by any person, firm, or corporation at USAKA. In order to work at USAKA, RMI residents must register with KALGOV and secure documentation required for employment. Contact by USAKA or its contractors with prospective Marshallese employees is controlled through referrals to KALGOV by the local RMI Government Representative at USAKA. KALGOV makes referrals for Marshallese who are registered for specific categories of employment.

3.10.2 POPULATION

USAKA

Table 3.10-4 summarizes the nonindigenous population and also indicates ABM missile launch activity and significant changes in activity at USAKA since 1962. USAKA's nonindigenous population peaked at 4,756 in 1971, then declined after range launch activity was reduced. Between FY76 and FY83, there were no major launch programs at USAKA. During this period and through 1987, USAKA's population continued to decline. The population decreased to an annual low of 2,577 in 1985 and a monthly low of 2,265 in December 1987. USAKA's population increased to 2,972 in December 1988 when construction activity on Meck and Roi-Namur Islands started.

Table 3.10-5 shows the distribution of the nonindigenous population at USAKA in December 1988. The population totaled 2,972 and comprised 1,892 employees (operations, construction, and transient) and 1,080 dependents.

Off-island hiring is the primary factor affecting the level of nonindigenous population at USAKA. Transient personnel on temporary duty add to the population for the durations of their assignments.

USAKA regulates access to the USAKA islands thereby controlling the level of resident population. USAKA's permanent resident population is limited to nonindigenous personnel and their dependents, with the exception of two RMI government representatives and their dependents who are based on Kwajalein Island. Dependents over 18 years of age are not allowed to remain as USAKA residents after they graduate from high school unless they are employed at USAKA. Transient personnel are allowed at USAKA only for their period of temporary duty. Visitors are allowed only if they are sponsored by a USAKA resident.

Ebeye and Ennubirr

Historic population numbers at Kwajalein Atoll are shown in Table 3.10-6. Preliminary data from the November 1988 RMI census indicate a population of 8,277 on Ebeye and 494 on

Table 3.10-4
HISTORICAL NONINDIGENOUS POPULATION
LEVELS AT USAKA AND ABM LAUNCH ACTIVITY[a]
1962 to 1988

Year	USAKA Population[a]	ABM Missile Launches	Other Comments
1962	3,110	0	NIKE-ZEUS construction completed.
1965	3,242	0	ICBM range construction begins.
1967	3,963	0	SENTINEL system organization begins.
1969	4,667	7	Spartan and/or Sprint testing programs, FY69 to FY75.
1970	4,732	14	
1971	4,756	12	
1972	4,649	13	
1973	4,564	16	
1974	4,152	6	
1975	3,666	8	
1976	3,104	0	No major launch programs at USAKA FY76 to FY83.
1977	3,331	0	
1978	3,131	0	
1979	3,028	0	
1980	2,953	0	
1981	2,836	0	
1982	2,982	0	
1983	2,843	0	
1984	2,662	4	HOE program and launches.
1985	2,577	0	
1986	2,633	0	
1987	2,601	0	
1988	2,972	0	Meck and Roi-Namur Islands construction activity begins.

[a]All figures represent average annual population except 1988, which reflects the December 1988 population.

Source: LTC Flythe, USASDC, May 1, 1989.

Table 3.10-5
DISTRIBUTION OF NONINDIGENOUS
EMPLOYEES AND DEPENDENTS AT USAKA
DECEMBER 1988

	Employees	Dependents	Total
Operations personnel			
Accompanied	541	1,053	1,594
Unaccompanied	962	0	962
Subtotal, Operations	1,503	1,053	2,556
Transient personnel[a]	22	0	22
Construction personnel	367	27	394
Total	1,892	1,080	2,972

[a]Transient personnel count is based on the average per day in December 1988.

Source: Pan Am World Services, Inc, Monthly Activity Report, December 1988.

Table 3.10-6
MARSHALLESE POPULATION AT KWAJALEIN ATOLL

Location	1935[a]	1945[b]	1954[c]	1961[d]	1973[d]	1980[d]	1988[e]
Kwajalein Atoll	452	516	1,278	1,443	5,469	6,624	9,254
Ebeye Island	16	ND	981	ND	5,123	6,169	8,277
Outer Islands	ND	ND	297	ND	346	455	977
Ennubirr	ND	ND	ND	50[f]	190[g]	ND	494
Ennylabegan	ND	ND	15[f]	ND	74[g]	ND	67

Sources:
[a]Alexander, 1978.
[b]Bryan, 1954.
[c]Tobin, 1954.
[d]RMI, 1987a.
[e]RMI, April 1989. Report revises the total population for the atoll, exclusive of USAKA, to 9,311.
[f]Tobin, 1972.
[g]Tobin, 1972, for the year 1972, assumed to be representative of the 1974 population.

ND = no data.

Ennubirr (RMI, December 1988). These figures imply a population density on Ebeye (now about 90 acres or 0.14 square mile), of more than 59,000 per square mile. Figure 3.10-1 illustrates the densely populated, highly built-up environment of Ebeye and the less densely populated environment of Ennubirr.

Population growth on Ennubirr is attributed to natural population growth and to Marshallese moving there for construction employment opportunities on Roi-Namur. It is not established whether the Marshallese moving to Ennubirr reflect immigration or a movement of residents within the Kwajalein Atoll (personal communication, RMI government representatives).

3.10.3 HOUSING

USAKA

USAKA's housing units for nonindigenous operations employees are located primarily on Kwajalein Island and, to a limited extent, on Roi-Namur. Although USAKA operations personnel do not reside on any other USAKA islands, security is provided for all USAKA islands except Ennugarret.

Housing for nonindigenous construction workers has usually been located near construction sites. Construction camps (trailers) currently are located on Kwajalein, Roi-Namur, and Meck Islands. Construction personnel are also accommodated in UPH units, and construction management personnel with families are provided with family housing, if it is available.

Operations housing includes family housing, UPH, and transient housing. The existing housing mix for operations employees on Kwajalein and Roi-Namur Islands and existing substandard family and UPH are discussed below. USAKA has adopted AR 210-11 and AR 210-50 and the space requirements for new construction as defined by the U.S. Army Corps of Engineers (A-E Instruction-Design Criteria, 14 June 1988) as USAKA's standards for new family housing and new and renovated UPH, and is seeking to replace substandard housing with units that meet these standards. These standards do not apply to housing transient personnel, and the practice of accommodating transient personnel in open barracks, as well as in housing with two to three persons per room will continue.

Family Housing

Family housing units on Kwajalein are located in the northeastern one-third of the island. Table 3.10-7 indicates that USAKA's family units include 254 temporary trailers that were installed in 1962 and 1968; 128 permanent

concrete-block structures that contain 289 single-family and multifamily dwelling units built in the mid-1950s; and 136 new units in 24 townhouse structures, which were completed in 1989. Based on AR 210-50 and the Army Corps of Engineers' space requirements, 288 of the old permanent housing units and all of the 254 trailers are substandard. USAKA has initiated measures to replace the substandard units and trailers. The 136 new family units were intended to replace many of the substandard trailers; however, the trailers will be used through 1992 in order to accommodate unaccompanied personnel. As indicated in Table 3.10-7, if substandard units are included, there is currently a surplus of 124 housing units. However, if substandard units are excluded, there is a deficit of 418 units.

Table 3.10-7
USAKA NONINDIGENOUS FAMILY HOUSING UNITS

	Housing Units
Demand	555
Supply	
New permanent	136[a]
Old permanent (288 substandard)	289
Trailers (all substandard)	254
Total supply	679
Total excluding all substandard units	137
Net Surplus (Deficit) of Supply over Demand	
Including all units	124
Excluding substandard units	(418)

[a]Housing units completed in March 1989.

Source: Pan Am World Services, Inc., Monthly Activity Report, December 1988; and USAKA, personal communication.

Unaccompanied Personnel Housing

Based on AR 210-11 and Army Corps design standards, USAKA seeks to provide unaccompanied personnel with individual bedrooms and bathroom facilities to be shared by two persons.

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

EBEYE ISLAND

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ENNUBIRR ISLAND

Figure 3.10-1

Table 3.10-8 lists UPH units on Kwajalein and Roi-Namur. USAKA currently rents UPH units on Kwajalein to construction employees. In December 1988, 175 construction personnel were housed. There were 434 UPH units on Kwajalein Island located in nine two- and three-story walkup buildings. A mid-1988 USAKA report indicated that there were 763 unaccompanied personnel living in facilities that were intended for 434 persons (based on AR 210-11). Housing on Roi-Namur Island includes six walkup dormitories that provide UPH for 338 persons and new housing units that accommodate 96 persons. The dormitories do not meet the standards of AR 210-11. The new units meet AR 210-11 standards.

Table 3.10-8
USAKA NONINDIGENOUS UNACCOMPANIED PERSONNEL HOUSING UNITS

	Housing Units
Demand	1,137[b]
Supply	
Old permanent	772
New permanent	96[a]
Total supply	868
Total, excluding 348 substandard	520
Net Surplus (Deficit) of Supply over Demand	
Including all units	(269)
Excluding substandard units	(617)

[a]UPH units on Roi-Namur completed in mid-1989.
[b]Based on 962 unaccompanied operations personnel population and 165 construction personnel using UPH on Kwajalein Island in December 1988.

Source: Pan Am World Services, Inc., Monthly Activity Report, December 1988.

Transient Housing

USAKA accommodates transient personnel in open barracks, in housing with two and three persons per room, or, depending on availability, in UPH units. In 1988, improvements were begun on the old Kwajalein Lodge to modernize accommodations for 47 transient personnel; completion is scheduled for late 1989.

Ebeye and Ennubirr

Housing for the Marshallese potentially affected by USAKA activities is located primarily on Ebeye and, to a limited extent, on Ennubirr. A few Marshallese who work at USAKA reside on other islands. The 1988 RMI census indicates that there are 835 household units on Ebeye, with an average of 10 persons per household. A 1988 aerial photograph of Ennubirr shows between 50 and 60 residences (Figure 3.10-1).

Up to 200 new housing units are being developed by KADA on Gugeegu and construction is targeted to be completed in late 1989 or early 1990. The housing project will replace 76 homes destroyed by Tropical Storm Roy in January 1988. The remaining new housing would replace other housing units identified by KADA and would help meet the need for additional housing (Carleton Hawpe, April 29, 1989).

3.10.4 INCOME AND FISCAL CONDITIONS

USAKA

All base services (such as water, sewerage, road maintenance, education, medical, fire, and police) are provided by USAKA and its contractors. With the exception of funding for recreation (discussed in Subsection 3.10.5) all of USAKA's funding is derived from the U.S. government.

Data concerning the total income earned by USAKA nonindigenous personnel is considered to be confidential and proprietary and was not available.

At a minimum, $60 million was earned by USAKA contract employees in 1988 (based on RMI 5 percent income tax receipts of $3.3 million from residents of USAKA recorded in 1988).

Ebeye and Ennubirr

RMI and KALGOV are independent of USAKA and are responsible for funding and operating their own public services.

Table 3.10-9 is a summary of the estimated earnings of the Marshallese personnel employed at USAKA and indicates that in 1988, total direct earnings were approximately $10 million.

In 1988, nonindigenous construction and operations contract employees at USAKA paid approximately $3.3 million in income tax to the RMI government based on the fixed 5 percent income tax rate. This represents approximately $1,900 per construction and operations contract employee based on the December 1988 personnel data. The $3.3 million represents 22 percent of the $14.7 million in domestic revenues earned

Table 3.10-9
TOTAL EARNINGS AND AVERAGE HOURLY RATES
FOR MARSHALLESE WORKING AT USAKA-RELATED JOBS

	Total Employees	Annual Payroll (millions)	Average Wage per Hour
Base Support			
Pan Am	688	$8.0	$5.17
Others	41	0.5	3.60
Domestics	62	0.4	2.50
Construction	183	1.0	3.24
Job Corps	33	--	0.33
Total	1,007	$9.9	

Source: USAKA Host Nation Activities Office, December 14, 1988.

by the RMI government in 1988, or 5 percent of total RMI government revenues of $65.7 million (USAKA, 1988).

The Compact of Free Association sets forth the various grants and cash payments made by the United States for USAKA's use of the lands it occupies and the lagoon area it uses. The annual Compact payments include fixed payments plus payments that are adjusted for inflation (referred to as adjusted funds). Compact payments in 1988 totaled $42.4 million.

KADA was established by the RMI legislature and the Compact payments allocated to KADA are intended to benefit the Marshallese residents of Kwajalein Atoll. Improvements that have been funded by KADA funds include construction and operation of a new fuel-fired electrical generating plant and an associated desalination plant; construction of paved roads with curbs, gutters, and sidewalks; purchase and operation of a large, land-based dragline dredge that created fill areas at the south end of Ebeye for a new park and at the north end to cover the solid waste landfill and to create a new area for housing. KADA also proposes to construct Ebeye's first high school and expand its elementary school. KADA has started development of new housing on Gugeegu, and proposes to build a causeway to connect Ebeye and Gugeegu.

3.10.5 RECREATION

A range of recreational facilities is essential for maintaining morale and health in an isolated installation such as USAKA. USAKA's recreational facilities include many sport/fitness-oriented facilities (tennis, volleyball/basketball, and handball courts; softball fields; a running

track; swimming pools; two camps; a nine-hole regulation golf course and driving range; and swimming beaches), outdoor theaters, a marina with full services for marine recreation, and various hobby clubs. Formal recreational facilities and services are limited to Roi-Namur and Kwajalein Islands.

USAKA's recreational facilities are maintained and operated by Pan Am World Services, Inc., and are funded independently by USAKA residents through various retail and user fees. Funding for recreation depends on the level of personnel at USAKA, retail sales volume and profit margins earned, and user fees paid.

3.10.6 EDUCATION

USAKA's educational programs include preschool; elementary, junior, and senior high schools; and adult education. All of USAKA's educational facilities are on Kwajalein and are operated by Pan Am World Services, Inc.

USAKA has no child-care facilities for infants and toddlers. USAKA reports that this shortfall has inhibited recruitment of single parents. An analysis conducted in conjunction with the preparation of the USAKA Master Plan report concluded that a facility is needed for the 6-month to 5-year age group.

Table 3.10-10 summarizes the school enrollment for grades K through 12 for the 1987 to 1988 and 1988 to 1989 school years and indicates that school enrollment increased by 71 students in the 1988 to 1989 school year. Enrollment increased by 57 students in grades K through 6 and by 14 students in grades 7 through 12. The increased enrollment coincides with the change of base contractors in 1988, and is attributed to the fact that Pan Am World Services' employees are younger and have more children than the former base contractor personnel. The Ivey School, which serves grades K and 1, currently has 99 students, an increase of 16 compared with the 1987 to 1988 school year. Grade K currently has a double shift, with two morning sessions and one afternoon session. Elementary school enrollment in grades 2 through 6 has increased to 167 students, compared with 126 during the previous school year. The increased enrollments will necessitate expansion of the elementary school. Enrollment in grades 7 through 12 is 149 students, compared with 135 during the previous school year.

According to the USAKA school superintendent, capacity problems are beginning to occur in the educational facilities at USAKA, particularly in the preschool and grades K through 6. USAKA had a total of 34 teachers for the school year 1988 to 1989, representing a student/teacher ratio of 12:1. Changes

Table 3.10-10
USAKA SCHOOL ENROLLMENT

Grade	Enrollment 1987 to 1988	Enrollment 1988 to 1989	Change
K	47	56	+9
1	36	43	+7
2	24	41	+17
3	20	34	+14
4	30	30	0
5	25	31	+6
6	27	31	+4
7	25	30	+5
8	20	24	+4
9	24	21	-3
10	24	24	0
11	27	23	-4
12	15	27	+12
	344	415	+71

Source: J. E. McCafferey, School Superintendent, March 1, 1989.

in enrollment levels have led to a review of teacher staffing as part of the annual budget process. When justified, new teachers are hired or teaching assignments are changed. An analysis of enrollment and classroom facilities conducted in conjunction with the preparation of the USAKA Master Plan report concluded that additional classroom space is needed to meet the increased enrollment levels in grades K through 6. Additionally, the report suggested that the need for additional classrooms may be satisfied by using space in Building 357, Ivey Hall, and in Building 352, George Seitz Elementary School (main building) that is currently used for non-school functions (USAKA, 1988). The same analysis concluded that no additional space is required for grades 7 through 12. Classrooms are being recovered from non-school uses and prefabricated classrooms may eventually be necessary.

In 1986, USAKA initiated a program to bring Marshallese children from Ebeye to attend school at USAKA, beginning with the kindergarten level. These students are selected by the local government in conjunction with USAKA and school personnel. In 1988 to 1989, there were five students each in grades K through 2. Eventually, Marshallese students will be placed in all grade levels.

3.10.7 HEALTH

USAKA

USAKA's hospital and medical facilities include both in-patient and out-patient care, and a dental clinic located at Ivey School. The 20-bed Kwajalein Hospital is a two-story facility constructed in 1951, with additions in 1968 and 1976. The existing hospital is the principal facility providing health care services for USAKA personnel and their dependents. It is equipped for emergency treatment, general surgery, pediatrics, obstetrics, in-patient care, pharmacy, clinical laboratory, and an intensive care ward. Medical services for Roi-Namur and Meck personnel are accommodated by clinics located on each island.

There have been three suspected cases of AIDS at USAKA. In each case, the source of the disease was traced to areas outside the Kwajalein Atoll. Currently, there are no known cases of AIDS at USAKA.

There have been no incidents of EMR-related health problems at USAKA.

Ebeye and Ennubirr

RMI government reports indicate that the five principal causes of death among Marshallese are early infancy diseases, influenza and pneumonia, diarrhea and intestinal diseases, diabetes, and heart disease. A rise in the incidence of chronic diseases is associated in part with western habits of smoking and alcohol consumption and with diet changes.

In the past, some of the major factors contributing to health-related problems on Ebeye and Ennubirr included contaminated water supplies (attributable to roof catchment systems), inadequate sewage and refuse collection and disposal, and disease vectors (such as the bush fly). All of these were exacerbated by overcrowded living conditions in which diseases can be rapidly transmitted.

Since 1987, KALGOV has initiated regular garbage collection and systematic disposal and has constructed a new KADA-financed desalination plant in association with the new electric plant. The sewage collection and disposal system was upgraded in the mid-1980s, and further upgrading of the system has been given the highest priority by both the RMI and KALGOV governments in their master planning. Levels of gastrointestinal diseases have declined since the early 1980s on Ebeye, however, levels of gastrointestinal diseases remain high on Ennubirr.

3.11 TRANSPORTATION

Kwajalein's isolation and island geography make transportation vital to USAKA. The marine and air transportation modes used to move people and supplies into and out of Kwajalein Island, as well as between Kwajalein Island and the other islands in the atoll, are particularly critical to USAKA's operations.

The following sections describe existing transportation systems at USAKA, focusing on air, land, and marine transportation facilities and operations and their interrelationships. Transportation facilities are identified in Figures 3.9-1 through 3.9-3. The region of influence for transportation includes the 11 USAKA islands, plus Ebeye for marine transportation. However, mechanized transportation at Kwajalein Atoll is centered on Kwajalein, Roi-Namur, and Meck Islands, which are the focus of the following discussion. The other islands, served less frequently by marine transportation and/or helicopter, are discussed in less detail.

Two sources of information were used for existing air, land, and marine transportation facilities: the USAKA Master Plan Report (USAKA, 1988), and the "Analysis of Existing Facilities" (Pan Am World Services, June 1988). Transportation operations information was obtained from the monthly activity reports prepared by Pan Am World Services for October 1987 and October to December 1988.

3.11.1 AIR

Air transportation personnel at USAKA have indicated that at USAKA, facilities are not the limiting factor to increased air operations; the existing demand on the runways and helipads is insignificant compared to the capacity of the facilities. Instead, the limiting factor to increased operations is the number of aircraft and the number of personnel required to maintain and operate them. Based on information provided by air officials on USAKA, the aircraft are currently operating at capacity and any increase in flight requirements would necessitate the addition of aircraft and support personnel. In addition, the capacity for shipment of explosives is limited by the restricted zones for explosive storage and the "hot spots."

3.11.1.1 Facilities

Kwajalein

Bucholz Army Airfield on Kwajalein serves as a refueling point for a wide variety of military and civilian transient

aircraft. Aircraft ranging from Lear jets to Military C-5 transports use Kwajalein as an enroute stop.

Local air service between islands is provided by nine aircraft operated by Pan Am/DynCorp for USAKA: four Shorts SD3-30 turbo-prop aircraft (for service between Kwajalein and Roi-Namur) and five UH-1H helicopters (for service to the other islands in the atoll, which are too small for adequate runways).

Long-distance air service is provided by the Airline of the Marshall Islands (AMI), Continental Air Micronesia, and the Military Airlift Command (MAC). AMI uses three turbo-prop aircraft (DO-228 and HS-748) for frequent flights between Kwajalein, Majuro, and other islands within the Marshall group. Continental Air Micronesia operates Boeing 727 aircraft through Kwajalein eight times a week providing four eastbound flights through Majuro and Johnston Island that terminate at Honolulu, and four westbound flights through Ponape and Truk that terminate at Guam. MAC operates C-141 aircraft three times a week between Hickam AFB, Hawaii, and Kwajalein. Passengers and critical cargo are the payloads for these flights.

Bucholz Army Airfield has a Class A, bituminous concrete runway, 6,673 feet long by 200 feet wide with instrument landing system (ILS) facilities and approaches. Access to the runway, parking apron, terminal, and aircraft shops is provided by a parallel, bituminous concrete taxiway. An emergency runway repair contract is currently underway to overlay the existing asphalt concrete pavement and repair pavement areas that have settled.

Roi-Namur

Dyess Army Airfield on Roi-Namur has a bituminous concrete Class A, visual flight rules (VFR) runway, 4,500 feet long by 150 feet wide with a short, bituminous concrete taxiway leading to the parking apron.

Other Islands

A third runway, located on Meck Island, is no longer authorized for use by fixed-wing aircraft. This facility still serves Meck Island as a helipad and water catchment basin. Air service to the other islands is provided by UH-1H helicopters. Eniwetak, Ennylabegan, Gagan, Gellinam, Illeginni, Legan, and Omelek Islands each have 10,000-square-foot helipads. The helipads are constructed of a bituminous road mix pavement on a 6-inch base course of compacted coral.

3.11.1.2 Operations

Table 3.11-1 summarizes the air transportation operations for the month of November 1988, a month typical of the

Table 3.11-1
USAKA MONTHLY AIR TRANSPORTATION OPERATIONS
(November 1988)

Operation	Type	Total Arrivals and Departures
MAC	C-141	32
Continental/Air Micronesia	B-727	68
Transient Aircraft:		
USAF	C-130	6
USAF	C-141	6
USN	C-12	2
AMI	DO-228	66
AMI	HS-748	28
COE	G-II	2
FAA	B-727	4
USMC	C-130	6
Australia	P-3	4
Australia	C-130	2
Japan	C-130	4
USAKA Aircraft:	UH-1H	618
	SD3-30	703

Source: Pan Am World Services, November 1988.

current atoll air operations. Aviation operations follow USAKA safety regulations and no accidents have occurred for several years.

Other representative aircraft that use the USAKA facilities include the C-5, F-111, LR-35, and the C-210.

3.11.2 GROUND

3.11.2.1 Facilities

The existing road system can support all vehicular, bicycle, and pedestrian traffic for any population that could be supported on the islands. The capacity of the ground transportation system is not dictated by the number of vehicles the system will handle, but by the inventory and operation of existing vehicles. According to ground transportation officials, the present fleet of vehicles is operated at the

capacity of the personnel available to operate and maintain them.

Virtually all mechanized ground transportation is on Kwajalein and Roi-Namur Islands. Ground transportation systems on Kwajalein and Roi-Namur consist of roadways and pathways used by motor vehicles, bicycles, and pedestrians. Walking and bicycling are the primary means of transportation for most island residents to get to work places, shopping areas, schools, and social events. Motor vehicles are used almost exclusively for work and administrative functions.

Almost 700 government- or contractor-owned motor vehicles and other pieces of equipment are located on Kwajalein and Roi-Namur Islands. Private automobiles may not be brought to USAKA. Motor vehicles range from motor scooters to semi-tractor trailers and include other types of vehicles such as forklifts, cranes, backhoes, front-end loaders, street sweepers, and tank trucks.

Kwajalein

On Kwajalein there are approximately 13 miles of paved roads, most between 20 and 24 feet in width. The pavement consists of a wearing course of 1-1/2 inches of sealed bituminous paving over a 6-inch base course of compacted coral. There are also approximately 6.5 miles of unpaved roads.

Bicycles are used as the main mode of personal transportation, and there is an average of about one bicycle per person on the islands. Most pathways are shared jointly with pedestrians. Major bicycle paths (including sidewalks) are largely found in the community support, bachelor, and family housing areas of the island. The existing bike paths are generally narrow and are not designed to accommodate passing bicycles or walking pedestrians without one party moving off the paved surface.

All existing island roads are used jointly by bicycle and other vehicle traffic regardless of surfacing and traffic conditions. "Bicycle only" lanes are not designated on any roads, primarily because of the narrow roadway widths and generally low volumes of traffic.

Shuttle buses and vans are used to transport personnel from residential areas to community service and work centers. Two types of service are provided. Work buses serve established routes during the morning, noon, and evening peak work periods. Buses serve most of the island, as the walking distance to pickup points is relatively short. Passenger vans provide radio-dispatched shuttle service for

individual passengers to reach specific designations during and after normal working hours. There are typically three vans in service during any one period.

Additional multipassenger transportation services are provided on an as-needed basis for school and recreational events, shuttling Marshallese between the air and ferry terminals, and for special groups of visitors.

Roi-Namur

On Roi-Namur, there are approximately 8 miles of paved roads that vary in width from 16 to 20 feet, and 1 mile of unpaved road. The half-mile-long paved road from the fire station to the fuel pier consists of 1-1/2 inches of sealed bituminous paving over a 6-inch base course of compacted coral. The remainder of the roads have a thin bituminous cold-mix cover over a base course of approximately 8 inches of compacted coral.

The number of vehicles in use on Roi-Namur is typically very low, as most residents travel on foot or bicycle. Only 50 vehicles are on the island at present. Personnel who commute by plane from Kwajalein reach their destinations by use of three shuttle buses, via bicycle, or on foot.

Other Islands

Because the other islands have no permanent population, there are few transportation vehicles assigned to them. Meck Island has several vehicles to support the construction currently under way there. Ennylabegan and Illeginni also have one or two vehicles.

All roads on the other islands are considered to be local and are primarily for pedestrian use. Meck currently has approximately 1 mile of paved road and Ennylabegan has 1 mile of paved and one-half mile of unpaved roads.

3.11.2.2 Operations

Table 3.11-2 is a summary of the monthly average number of ground transport passengers on Kwajalein and Roi-Namur.

Table 3.11-3 is a summary of the operations of the general purpose and passenger vehicles for the fiscal year ending September 30, 1988.

Table 3.11-2
AVERAGE MONTHLY SHUTTLE/BUS PASSENGER COUNT
KWAJALEIN AND ROI-NAMUR

	1988 Monthly Average
Kwajalein shuttle bus passengers	19,786
Kwajalein special bus passengers	2,377
Kwajalein work bus passengers	4,340
Roi-Namur work bus passengers	12,630

Source: Pan Am World Services, June 1988.

Table 3.11-3
GENERAL PURPOSE AND PASSENGER VEHICLE OPERATIONS SUMMARY
KWAJALEIN AND ROI-NAMUR

Vehicle Type	Average In-Use Vehicle Inventory	Miles Operated
Automobiles	2	7,000
Ambulances	4	5,000
Buses	10	78,000
Trucks <8,500 lbs	232	1,245,000
8,501 to 23,999 lbs	37	104,000
>24,000 lbs	17	25,000
Total, all vehicles	302	1,464,000

Source: Pan Am World Services, October 1988.

3.11.3 MARINE

3.11.3.1 Facilities

Ocean cargo is provided to USAKA by barge and tug and arrives every 28 days at Kwajalein. Liquid fuel is brought by tankers that make an average of two calls per quarter. Local water transportation is provided by government-owned vessels operated by Pan Am/DynCorp. Vessels include two harbor tugs; three 1,466-class landing craft, utility (LCUs); five landing craft, materiel (LCMs); two high-speed catamaran ferries; one 65-foot personnel boat; five barges; and two patrol boats.

Two catamarans, an LCM, and the personnel boat are used for over 100 trips each week between Kwajalein, Ebeye, and Meck

Islands. The tugs and barges carry cargo and construction material to Meck and Roi-Namur or any other island that requires them.

Water transportation officials have indicated that the present fleet of vessels operates well below capacity.

Marine transportation facilities for the atoll are concentrated mainly on Kwajalein Island. There is a T-shaped fuel pier of reinforced concrete pilings and railings located behind the fuel farm. There is also an L-shaped cargo pier (Echo Pier) consisting of a concrete wharf with a cargo dock space at its end. Although almost any number of ships can be moored in the harbor of Kwajalein lagoon, cargo-handling facilities are quite limited and only one ship can be unloaded at a time.

Dredging of the lagoon is required periodically to maintain the depths necessary for vessels using the harbor. In 1988, 4,140 cubic yards of material were dredged at the barge bulkhead. This was the first dredging to be done in this area in approximately 10 years.

Roi-Namur has both a cargo pier (Yokohama Pier) and a cargo/fuel pier, located near the fuel tanks.

Meck Island has a concrete pier for the loading of cargo and personnel. This pier and the concrete marine ramp, are currently being refurbished as a part of the ERIS program. In addition, a small breakwater and a small terminal structure will be built and some additional dredging will be done as part of the Small Craft Berthing Facility project.

Ebeye also has a pier that extends into the lagoon for the loading of cargo and personnel traveling to and from Kwajalein. The remaining islands contain either a small pier, a concrete marine ramp, or both.

Periodic dredging is required at all of the island harbors and extensive dredging has been done on Meck and Legan Islands in recent years. In 1988, Legan, Ennylabegan, and Gellinam Islands each had 4,000 cubic yards dredged near their piers.

3.11.3.2 Operations

The water transportation operations for the month of November 1988 are shown in Table 3.11-4. The numbers in the table are representative of the current operations at the atoll.

The scheduled ferry trips consist of approximately 100 round trips each week between Kwajalein and Ebeye to carry the

Marshallese workers to and from work, and 10 round trips per week between Kwajalein and Meck Island. The ferry from Roi-Namur also carries Marshallese workers on its 6-mile round-trip to nearby islands.

Table 3.11-4
SUMMARY OF MARINE TRANSPORTATION OPERATIONS AT USAKA

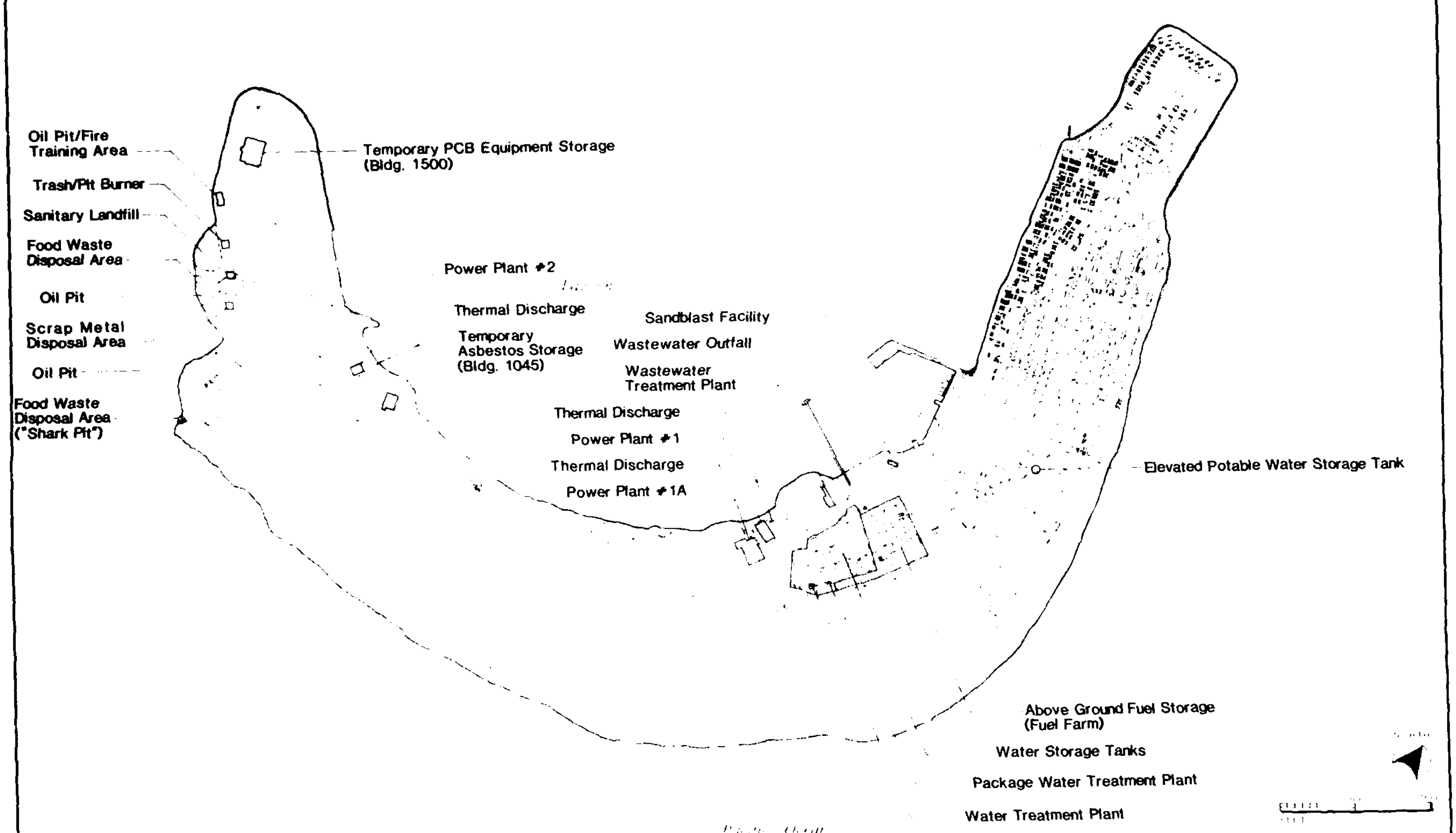
Operation			November 1988
Oceangoing ships using port			6
Total days spent in port			23
	Kwajalein	Roi-Namur	Total
Scheduled ferry trips	403	49	452
Nonscheduled ferry trips	0	0	0
Scheduled cargo trips	28	2	30
Nonscheduled cargo trips	6	1	7
Mission support	5	1	6
Search and rescue	0	0	0
Recreation trips	3	0	3
Barge trips	9	6	15
Tug trips	13	7	20
VIP trips	1	0	1
Total	468	66	534
Passengers carried	47,929	4,081	52,010
Operating hours	834	210	1,044

Source: Pan Am World Services, November 1988.

3.12 UTILITIES

The development of Kwajalein Atoll as a military installation required that the full complement of utility facilities found in most small towns in the United States be constructed on several of the islands. On Kwajalein and Roi-Namur Islands, utilities include permanent facilities for water supply; wastewater collection, treatment, and disposal; solid and hazardous waste disposal; and power generation. On the other USAKA islands, utility facilities are less well developed and generally consist of power generation and temporary water and wastewater storage facilities.

The following sections describe the existing utility facilities on the 11 USAKA islands. Figures 3.12-1 and 3.12-2 illustrate major utility facilities on Kwajalein and

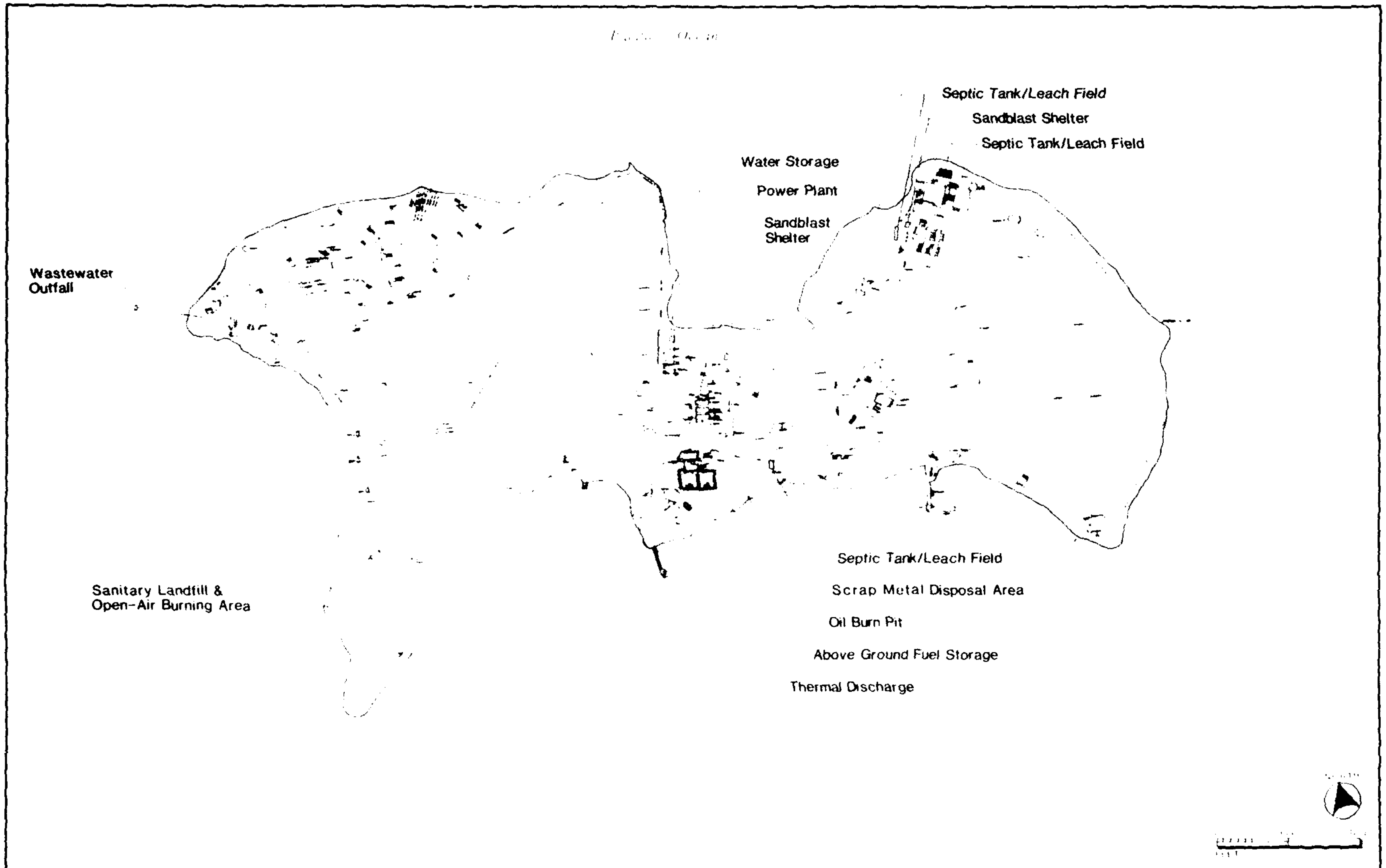


U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

UTILITY FACILITIES

KWAJALEIN ISLAND

Figure 3.12-1



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

UTILITY FACILITIES
ROI-NAMUR ISLAND

Figure 3.12-2

Roi-Namur Islands. A final section describes energy consumption at the USAKA installation.

3.12.1 WATER SUPPLY

Water supply at USAKA is made up of potable (freshwater) and nonpotable (saltwater) systems. Table 3.12-1 summarizes water demand and available supply for Kwajalein and Roi-Namur. Bottled water is purchased by island residents to supplement drinking water and for reserve water in the event of an emergency.

Table 3.12-1
WATER DEMAND AND AVAILABLE SUPPLY
(gpd)

	Demand	Available Supply		
		Groundwater	Catchments	Total
Kwajalein				
Normal year	280,000	140,000[a]	290,000	430,000
Drought year	280,000	140,000	90,000	230,000
Roi-Namur				
Normal year	35,000	130,000[b]	26,000	156,000

[a] When sustained yield is 50 million gallons per year.
[b] When operated continuously for 2 of 6 wells, equals 47 million gallons per year.

3.12.1.1 Potable Water Systems

Kwajalein

The potable water system for Kwajalein can provide the local population with an adequate supply under normal conditions. Although turbidity exceeds proposed maximum limits of the 1986 Amendments to the Safe Drinking Water Act (SDWA) much of the time, the turbidity values should be within limits after a new 400-gpm package water treatment plant is installed ahead of the existing filtration units. This plant is planned to be installed in 1989.

The daily demand for water is in the range of 200,000 to 300,000 gallons per day (gpd). During the period October 1988 through February 1989, average use was 280,000 gpd, or about 110 gallons per capita per day (gpcd). During the same period, varying amounts of water (up to 250,000 gallons per month) were provided from Kwajalein Island sources for use on other islands and for ships.

Portable reverse osmosis units were installed during the 1984-1985 drought to desalt brackish water from two wells located near the water treatment plant. These units are now inoperable.

The lens well system has been heavily used during the past year because of high turbidity associated with the catchment water caused by construction activity in the immediate area. About 60 million gallons of water have been withdrawn from the lens wells system during the past year.

Fifteen 1-million-gallon, reinforced-concrete tanks are used to store water that is collected from the catchments and lens wells. The raw water is filtered and discharged to the distribution system after pH adjustment and chlorination. A 100,000-gallon elevated steel reservoir provides water storage for system operations and fire protection.

Treated Water Quality

Treated water quality for Kwajalein is analyzed annually for compliance with the U.S. National primary drinking water standards. The U.S. Army Pacific Environmental Health Engineering Agency reviewed the 1983 through 1986 analytical results of annual monitoring and conducted additional special analyses during a June 1986 study. The physical and chemical quality of the potable water provided was characterized as being of excellent quality, except for the marginal values for turbidity.

As part of the U.S. Army Drinking Water Surveillance Program, a sample of drinking water from Kwajalein was analyzed in 1988 for maximum contaminant levels (MCL) and secondary maximum contaminant levels (SMCL) as established under the National Primary and Secondary Drinking Water Regulations. Analysis for all tested constituents showed that they were below the MCL and SMCL levels. Results of the radiological analysis also showed no measurable radiological contamination.

Roi-Namur Island

An adequate supply of potable water of suitable quality is provided to the local population of Roi-Namur under normal conditions. Two catchments and a system of lens wells are the sources of water. The two catchments yield a total of 600,000 to 800,000 gallons per month and six lens wells, each with a 45-gallon-per-minute capacity, provide the remaining 250,000 to 400,000 gallons of water per month needed to meet demand, especially during the dry season. Daily demand reaches 35,000 gpd. A portion of the water is supplied to Ennubirr for domestic use. This practice will

be discontinued during 1989 when a catchment for rainwater on Ennubirr will be activated.

Raw water from the catchments and lens well system is stored in two 0.75-million-gallon steel tanks. After treatment, the water is discharged to a single 50,000-gallon elevated storage tank that is linked to the distribution system.

Meck

The source of potable water on Meck Island is a rainwater catchment adjacent to the airfield runway. Two tanks, 0.25-million-gallon and 0.50-million-gallon, store raw freshwater. The water is filtered and chlorinated before being pumped to the system. No treated water storage is provided.

Ennylabegan

The helipad acts as a catchment for the potable water system at Ennylabegan. The raw water is stored in two 0.145-million-gallon tanks. After filtration and chlorination, the water is pumped to the distribution system.

Other Islands

The other USAKA islands (Illeginni, Omelek, Gagan, Gellinam, Eniwetak) and Ennubirr are all without active, developed potable water systems. Personnel working on these islands carry water for consumption and other uses, as necessary.

3.12.1.2 Nonpotable Water Systems

The primary nonpotable systems are located on Kwajalein, Roi-Namur, Ebeye, and Ennylabegan Islands. Nonpotable water is used for flushing toilets, power plant cooling water, and fire fighting. Nonpotable water is also supplied to the two saltwater swimming pools on Kwajalein. The systems are functional; however, the sea water pumping station on Roi-Namur is susceptible to breakdown during storms and needs more capacity. Although the nonpotable distribution system on Kwajalein provides adequate capacity, it is in poor condition because of age and the variety of piping materials used in its construction.

3.12.2 WASTEWATER COLLECTION, TREATMENT, AND DISPOSAL

Kwajalein

The wastewater system for Kwajalein consists of a gravity collection system, nine pump stations, a secondary treatment plant, and an outfall extending into the lagoon. The collection system is over 30 years old and may be deteriorating

substantially. The pump stations have all recently been rebuilt and fitted with submersible pumps. The wastewater treatment plant is about 9 years old and has a design capacity of 450,000 gpd. The plant is an activated sludge plant with associated treatment basins and ancillary equipment. The treated waste is chlorinated prior to discharge to an outfall extending into the lagoon (Figure 3.12-1). Waste solids are stabilized by aerobic digestion prior to being dried in sand beds. Dry sludge is disposed of on the grounds of the plant or used by residents for their gardens.

The influent at the plant is primarily domestic wastewater. About 200,000 gpd of non-potable water is contributed to the total wastewater flow. The influent biochemical oxygen demand and suspended solids are generally in the range of 120 to 170 milligrams per liter (mg/L) and 120 to 150 mg/L, respectively. Effluent typically has less than 20 mg/L suspended solids and 5 mg/L biochemical oxygen demand.

Wastewater flow for the period September 1988 through February 1989 averaged 465,600 gpd, a value just exceeding the nominal plant design capacity of 450,000 gpd. It is apparent that the plant handles the existing flow well, as exhibited by its good performance record. The wastewater flow is about 180 gpcd.

The Kwajalein wastewater treatment plant is near its design hydraulic capacity. The organic loading of the plant appears to be at nearly 70 percent of the design organic capacity, based on the population currently served.

Roi-Namur

Roi-Namur has four septic tank/leach fields and one outfall to the ocean, as shown in Figure 3.12-2. The existing wastewater flow is about 43,000 gpd through the outfall. The Roi-Namur raw wastewater biochemical oxygen demand was found to be 216 mg/L during the Roi-Namur Wastewater Treatment and Disposal Study (Sea Engineering, Inc., 1989). The leach field serving the TRADEX building was replaced in February 1989.

Other Islands

Meck and Ennylabegan each use three septic tank/leach field systems. Illeginni and the remaining outer islands handle wastewater by storing it in portable tanks before transporting it back to Kwajalein for treatment and disposal.

3.12.3 SOLID WASTE

The solid waste utility at USAKA includes facilities and operations for waste collection, sorting, and disposal for

municipal waste, construction debris, and the waste products of routine base operations. The primary sources of information were study reports of solid waste collection and disposal practices. These reports include environmental assessments of sanitary landfilling and ocean dumping by the U.S. Army Corps of Engineers (1976 and 1977), the USAKA Master Plan Report (CH2M HILL and Belt Collins and Associates, 1988) and a study of waste management practices by GMP Associates (1989).

Interviews were conducted with USAKA engineering personnel about current solid waste collection, categorization, separation, and disposal practices. Solid waste management practices and disposal areas were observed. Primary data included the types of waste handled and the disposal methods for each of these wastes.

For the analysis of the municipal waste, the collection and disposal methods for municipal waste were examined and compared to existing EPA regulations. The disposal of construction wastes was evaluated with respect to EPA regulations, and the Clean Air Act, in the case of asbestos, which is found in many older structures. For the operation and maintenance of base facilities, the generation, collection, and disposal of solid waste was evaluated based on federal regulations and guidelines intended to prevent the migration of pollutants from disposal areas to groundwater and surface water resources.

3.12.3.1 Municipal Solid Waste

Municipal solid waste (MSW) is defined here as garbage, refuse, medical wastes, or sewage sludge/septage. Two of the 11 USAKA islands (Kwajalein and Roi-Namur) have established MSW collection, transportation, and separation operations. These operations do not exist on the other USAKA islands.

Estimated loads of 20 to 30 tons per day are collected on Kwajalein with existing equipment. Following collection, the MSW is separated into combustibles, noncombustibles, residential refuse, and institutional food wastes. Combustible materials typically include paper, plastic, and landscape debris; while non-combustible materials include glass and metal scrap. Medical wastes are collected from separate dumpsters; and septage from grease traps and septic tanks is collected in a tank truck.

Most MSW generated on Kwajalein, including medical wastes, is incinerated in a forced-air burning pit or in open-air burning piles located at the Kwajalein landfill area (Figure 3.12-1). Remaining ash and non-combustibles are spread

over the landfill, and bulk metal is moved to a scrap metal pile.

Scrap metal was previously discarded by ocean dumping, but the permit has expired. Classified documents and film are incinerated separately. Other photo lab wastes are disposed in the Kwajalein landfill. Food wastes are disposed of in the ocean off Kwajalein. Stabilized sewage sludge is spread on wastewater treatment plant grounds and dewatered sludge is used as a soil conditioner on the golf course and in gardens. Septage is placed in an open trench at the landfill.

All MSW generated on Roi-Namur, except food waste, is burned in an open-air burning pile located at the Roi-Namur landfill area (Figure 3.12-2). Handling of ash and noncombustibles duplicates practices on Kwajalein. Food wastes are fed to island pigs and poultry. Septage is buried in excavated trenches on Roi-Namur, Meck, and Ennylabegan.

In summary, solid waste disposal practices on Kwajalein and Roi-Namur include open burning of solid waste, septage disposal and burial in open or excavated trenches, and operation of open dumps.

3.12.3.2 Construction Solid Waste Storage and Disposal

Construction solid waste consists of construction debris and asbestos. Construction debris is present on Kwajalein, Roi-Namur, Meck, Illeginni, and Omelek. There is no organized program for the disposal of this debris. It is either left in place or moved to a point where it does not inconvenience daily operations. Ongoing activities involve significant construction at USAKA, which generate bulk scrap consisting of steel tanks, abandoned vehicles, machinery, equipment, power cable, steel beams, reinforcement steel, and other debris. After Kwajalein, Meck currently produces the highest volume of bulk scrap as a result of current construction. During a trial period, scrap metal was used for shore protection at Kwajalein, Roi-Namur, Meck, Ennylabegan, Illeginni, Gagan, and Gellinam, but the practice was abandoned. The scrap metal was left scattered along the shoreline.

Asbestos is being removed from buildings at USAKA as a result of ongoing maintenance and general building rehabilitation. Although there have been cases when piping insulated with asbestos was left in place (new construction placed around the old), most piping and other equipment were generally removed with the insulation intact, and taken to the island landfills after being wrapped in plastic. Asbestos has been previously buried on Kwajalein, Roi-Namur and Meck. After extensive friable asbestos-containing material was discovered in Building 1045 on Kwajalein, the building was

abandoned; it is now used to store asbestos-containing material.

3.12.3.3 Operations Solid Waste Storage and Disposal

Operations solid waste consists of small scrap materials, empty containers, batteries, waste oils and lubricants, and sandblasting grit. Piles of minor scrap materials and empty containers can be observed on all of the islands except Ennugarret. An estimated 650 spent batteries are generated per year on Kwajalein, Roi-Namur, and Meck. The automotive, marine, and aviation departments generate more than 90 percent of the spent lead-acid batteries, and the Meck power plant generates the balance. Each operations department typically drains the batteries and neutralizes the acid. Then the solution is either discharged to the sanitary sewer, taken to the landfill for disposal, or left to evaporate. The Meck power plant ships its batteries intact in sodium bicarbonate to the Kwajalein landfill. The spent lead-acid batteries are not reclaimed or recycled.

Sandblasting is conducted regularly on Kwajalein, Roi-Namur and Meck as a result of frequent painting activities. Intermittent sandblasting operations are conducted on the outer islands. On Kwajalein and Roi-Namur, boats and other equipment are blasted on the edge of the lagoon while land vehicles are treated at a designated site. Portable sprayers are used on the other islands. Sandblasting activities lack controls to prevent the spread of paint and metal constituents around the areas of operation.

3.12.4 HAZARDOUS MATERIALS AND WASTE

Hazardous materials and waste facilities include the storage of hazardous raw materials, and the collection, storage, and disposal of hazardous wastes. Hazardous wastes are defined as specific compounds and waste materials having hazardous characteristics or being generated by certain categories of operations.

All 11 USAKA islands, except Ennugarret, have been affected by operations that require the use of hazardous materials such as fuels, paints, cleaning solvents, or lubricants to sustain operation. Other hazardous materials have been used on the USAKA islands for specific testing programs.

Hazardous materials storage facilities were evaluated based on the potential for fire, human exposure and environmental pollution. Primary sources of data were study reports of hazardous waste collection, storage and disposal practices. These reports include the USAKA Master Plan Report (CH2M HILL and Belt Collins and Associates, 1988), an assessment of hazardous waste management by Pan Am World Services (1988), and a waste management plan by GMP Associates (1989).

USAKA engineering personnel were interviewed about fuels and hazardous raw materials storage and handling procedures. Materials storage and user facilities were inspected. Personnel from the USAKA Safety Office were interviewed about explosives and propellent handling and storage. Both sources were interviewed about hazardous waste and unexploded ordnance collection and disposal methods.

Fuels and hazardous raw materials storage and handling practices were evaluated by examining tank inventory records and drum storage areas to determine the amount of materials and type of storage facilities. Existing practices were compared with federal regulations and guidelines intended to prevent spilled materials from contaminating soils and migrating to groundwater and surface water resources. Ordnance and propellent storage procedures were evaluated based on USAKA and Department of Defense regulations.

Hazardous waste management practices were characterized by examining the types of wastes generated at various USAKA operations and current disposal practices. These practices were compared to existing federal regulations and USAKA regulations for handling explosive wastes.

3.12.4.1 Hazardous Materials

Hazardous materials consist of fuels, solid rocket boosters and liquid propellants, explosives, solvents, petroleum oils and lubricants, and pesticides. Fuels are stored primarily in aboveground tanks at USAKA, but there are approximately ten fuel underground storage tanks on Kwajalein. Underground storage tanks containing fuel are regulated under Subtitle I of the Resource Conservation and Recovery Act (40CFR 280).

Aboveground tanks store fuel on Kwajalein, Roi-Namur, Meck, Ennylabegan, Legan, Illeginni, Gagan, Gellinam, Omelek, and Eniwetak. More than half of the 33 aboveground fuel storage tanks are located on Kwajalein. Containment for these tanks consists of combinations of concrete, coral, or asphalt-lined coral berm walls and floors. The berm walls appear to be adequate for fire protection, but their design may not provide sufficient capacity to contain a major release. The coral and asphalt-lined coral floors are not impervious enough to contain releases, and the concrete floors have numerous cracks and gaps. USAKA engineering personnel reported that a layer of hydrocarbon was observed floating on the water table at Kwajalein in an excavation near Power Plant 1A (see Subsection 3.3.1). This observation lends evidence to the potential of leaking tanks and/or the lack of containment. These storage tanks are maintained by the Defense Logistics Agency.

USAKA uses explosives for construction activities, such as quarrying coral rock for aggregate, and for missile launch operations. The small amount of explosives used in missile launch operations are for booster separation and flight termination systems. These functions require less than a few pounds of explosives for each missile. The flight termination system is a safety system for in-flight missile destruction.

Missiles launched at USAKA contain no offensive explosive warheads. Also, no nuclear explosive devices are used in USAKA missile launch programs. These types of explosives are not stored at USAKA.

Explosives are stored in magazines that comply with the explosive quantity-distance criteria and storage compatibility requirements of USAKA regulation number 385-75, Explosive Safety, which is derived from DOD 5154.4S and DOD 6055.9-STD, DOD Ammunition and Explosives Safety Standards.

Solid rocket motors are stored and handled as explosives (USAKA regulation number 385-75) on Kwajalein, and at Meck, Roi-Namur, and Omelek, only in preparation for specific launches. Liquid propellants, such as monomethyl hydrazine and nitrogen tetroxide, are stored in separate explosive storage facilities that are monitored for propellant vapor.

Solvent and petroleum product use is generally limited to activities on Kwajalein, Roi-Namur, and Meck; however, periodic maintenance and painting activities occur on the outer islands. Materials for these activities are stored on Kwajalein, Roi-Namur, and Meck in 55-gallon containers that are elevated horizontally above unlined ground surfaces. Stained soil and surface water were observed, indicating the potential for contaminated groundwater. The small quantities on the outer islands are stored in small aerosol cans.

Small quantities of pesticides are used in conjunction with fly and rodent traps on Kwajalein and Roi-Namur. The pesticides and their containers appear to be adequately stored, handled, and used in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act.

3.12.4.2 Hazardous Waste

Hazardous waste consists of solvent-waste oil mixtures, asbestos, PCBs, acids/bases, batteries, and unexploded ordnance. Because asbestos is typically generated during demolition activities in the region of influence, it has been addressed in the Solid Waste section (3.12.3). Batteries are not typically subject to the hazardous waste regulations because they are generally reclaimed or recycled. Batteries are also addressed under Solid Waste (3.12.3).

Waste oil is generated primarily during maintenance and repair activities on Kwajalein and Roi-Namur, but smaller amounts are also generated on the outer islands. Other sources of oil include oil-water mixtures from the power plants and from the marine activities. Collected waste oil on Kwajalein and Roi-Namur is emptied into unlined, bermed pits for storage and disposal. Periodically, the contents of the pit are ignited (open burning), while the water (including rain water) is siphoned from the bottom of the pit with a hose. The water, which is contaminated with oil, is drained along an unlined path to the ocean. Observations at and around these pits suggest that the oil is seeping into the ground. The soil on the sides of the pit and along the path to the ocean are stained, suggesting that potential for groundwater contamination exists. Uncontrolled air emissions were observed during the open burning. Waste oil is not currently defined as a hazardous waste; however, if it is not burned for energy recovery in boilers and industrial furnaces or otherwise recycled, proper handling or disposal is required.

Solvent waste is generated on Kwajalein, Roi-Namur, and Meck during engine/parts cleaning and painting activities. Little to no solvent waste is generated on the outer islands. Both halogenated and nonhalogenated solvent wastes are generated by the paint shops, the aircraft and automotive maintenance shops, and program facility shops. The laundry has a distillation unit to recycle its dry cleaning solvent (tetrachloroethylene). Currently, approximately 3,300 gallons per year of segregated solvent waste are collected, but an unknown volume of solvent waste commingled with waste oil is collected. Some small amounts of solvent are left to evaporate outside, but most of this waste material is disposed of in the same unlined, bermed pits used for waste oil disposal.

An inventory identified 155 electrical transformers and 580 capacitors used on Kwajalein, Roi-Namur, Meck, Ennylabegan, and Gellinam that contain oils with PCBs. Transformers and drained oil are being stored in Building 1500 on Kwajalein while disposal by a mainland contractor is being contemplated. Oil contaminated with PCBs has been released in Building 1500 and has contaminated isolated portions of the concrete floor.

Unexploded ordnance from the World War II era is found on USAKA islands at a rate of approximately 5 pieces per month. Unexploded ordnance is reported to the Security office or to explosive ordnance disposal (EOD) personnel, who inspect, transport, store and render safe all ordnance. Unexploded ordnance that can be moved is stored in the EOD safe holding magazine. Periodically, unexploded ordnance is moved to Illeginni by boat, where it is destroyed.

3.12.5 ENERGY

The region of influence for energy includes the 10 USAKA islands that have electric utility systems and fuel storage (all but Ennugarret).

Most of the energy consumed on Kwajalein Atoll is used for the production of electricity. USAKA maintains power plants and related electric utility facilities on ten islands. Electricity is produced by engine generator sets burning diesel fuel marine (DFM) and is distributed by underground feeders. There are no electrical interties between islands.

Other sources of energy are fuels, including DFM used for vehicles and marine transport; motor vehicle gasoline (MoGas), which is also used for small boats; and JP-5, used for military aircraft. Bulk fuel is stored at the aboveground tank farm on Kwajalein Island. MoGas is stored in underground tanks at the auto shop and boat harbor on Kwajalein and in aboveground tanks on Roi-Namur. Limited supplies of DFM are stored in aboveground tanks at each power plant.

The primary source of information about energy at USAKA is the USAKA Facilities Requirements Evaluation--Electrical Systems--Existing Conditions, Shortfalls, and Future Requirements, an appendix to the USAKA Master Plan Report (CH2M HILL and Belt Collins and Associates, 1988).

Table 3.12-2 summarizes the existing power plant capacities, historical peak loads, fuel oil consumed in 1988, and fuel oil storage capacity at each plant. All fuel oil storage tanks are above ground and have a spill containment berm, with the exception of Eniwetak, Omelek, Gellinam, Gagan, and Legan.

Kwajalein Island. Power Plant No. 1 (Figure 3.12-1) provided 93 percent of the power generated for Kwajalein Island in 1988, producing 59,034,000 kWh and peak output of 9,550 kW. A peak in plant production occurred in 1971 with 71,288,000 kWh produced and a peak output of 11,500 kW. The plant has been in continuous operation since it was constructed in 1961. With the exception of Engines No. 1 and No. 6, all engines in the plant have been rebuilt in the last 2-year period. The average number of running hours per engine was 145,000 in March 1989, with the minimum and maximum hours being 131,000 and 148,000. The plant uses seawater, which is discharged into the lagoon, for indirect cooling of the engines.

Power Plant 1A is being constructed adjacent to Power Plant 1 and has a scheduled completion date of mid-1990. The plant has a capacity of 12,000 kW and will use seawater

Table 3.12-2
USAKA POWER PLANT SUMMARY

Island/Plant	No. Engines[a] & Size (kW)	Plant Capacity[a] (kW)	Historical Peak Load[b] (kW)	Date	1988 Fuel Consump[b] (gal)	DFM Storage Capacity[c] (gal)
Kwajalein						
Plant 1	9 x 1,500	13,500	11,500	Nov 72	4,450,000	70,000
Plant 1A[d]	3 x 4,000	12,000	-0-		-0-	
Plant 2	6 x 880	5,280	4,200	Oct 73	350,000	53,000
Roi-Namur	8 x 1,500	12,000	5,875	Jun 88	2,930,000	653,000
Meck						
Temporary	3 x 350	1,050	735	-	245,000	150,000
Ennylabegan	4 x 200	800	525	Sep 82	180,000	20,000
Illeginni	3 x 130	390	273	-	90,000	30,000
Eniwetak	3 x 60	180	84	-	30,000	10,000
Omelek	2 x 60	120	84	-	30,000	6,000
Gellinam	2 x 60 +2 x 130	380	266	-	90,000	7,500
Gagan	2 x 130	260	182	-	60,000	10,000
Legan	2 x 130	260	182	-	60,000	5,000
Totals					8,515,000	1,014,500

[a]Source: Pan Am World Services, Inc., June 1988. Telephone communication from Bob Walker, Utilities Manager, Pan Am World Services, April 1988.
[b]Source: USAKA monthly utility statistics--electrical. January 1971 to February 1989 (Pan Am World Services, Inc.). Power Plant 1A will be operational mid-1990.
[c]Source: Pan Am World Services, Inc., June 1988.
[d]Will be operational mid-1989.

for indirect cooling of the engines. Upon completion, this plant will be used to generate the bulk of Kwajalein Island's power requirements.

Power Plant 2 was built in 1961; its original engine generators were replaced in 1986. Seawater used for indirect cooling of the engines is discharged to the lagoon. The plant is operated during peak hours of the day and produced 7 percent (4,741,000 kWh) of the power generated on Kwajalein Island in 1988. Peak plant output for 1988 was 4,000 kW.

Historical peak loads for Kwajalein Island are shown in Figure 3.12-3. Table 3.12-3 shows the Kwajalein fuel farm storage capacity and throughput for 1988. Table 3.12-4 shows approximate annual fuel consumption by use. Historical fuel oil consumption for power production for Kwajalein Island is also shown in Figure 3.12-3.

Roi-Namur Island. The Roi-Namur power plant (Figure 3.12-2) was originally constructed in 1961 and was expanded in 1967. Seawater is used for indirect cooling of the engines before being discharged to the lagoon. Loads have gradually increased over time. Nineteen eighty-eight was the peak production year with a total load of 34,150,000 kWh and a plant peak load of 5,875 kW. Historical peak load and power plant fuel oil consumption are shown in Figure 3.12-3. Approximately 20,000 gallons of MoGas is stored on the island in aboveground tanks.

Meck Island. Island power is provided by three 350-kW engine-generators. Use of other fuels on this island is very limited because there are few vehicles. MoGas is stored in a 1,500-gallon, aboveground tank.

Ennylabegan Island. The existing engine-generators are scheduled to be replaced with comparable units. The peak for the plant occurred in 1982, with 3,139,000 kWh produced for the year and a peak load of 525 kW. The power plant also contains the controls, chlorinator, and filters for the island's freshwater system.

Table 3.12-3
KWAJALEIN FUEL FARM CAPACITY AND FISCAL YEAR 1988 THROUGHPUT
(gallons)

Fuel	Storage Capacity	1988 Throughput
DFM	6,468,000	12,905,424
JP-5	2,893,800	8,738,946
MoGas	630,000	690,480

Source: Pan Am World Services, Inc., June 1988. Communication from C. J. Abadie, Jr., Base Operations Manager, USAKA (March 22, 1989).

Table 3.12-4
APPROXIMATE YEARLY FUEL CONSUMPTION
(gallons)

Fuel	Power Generation	Automotive and Small Boat	Aircraft
DFM	8,515,000	41,000	--
JP-5	--	--	8,739,000[a]
MoGas	--	180,000	--

[a]Based on fiscal year 1988 throughput.

Source: Communication from C. J. Abadie, Jr., Base Operations Manager, USAKA (March 22, 1989).

Outer USAKA Islands

The outer islands each have a small diesel-fired power plant with individual unit sizes, typically 60 kW and 130 kW, and total installed capacities ranging from 120 kW to 390 kW. All buildings, with the exception of the Illeginni Plant, are of sheet metal construction. All engine generators are 125/216 volt, 60 cycle, 1,800 rpm, and are skid-mounted with closed-loop cooling.

3.13 AESTHETICS

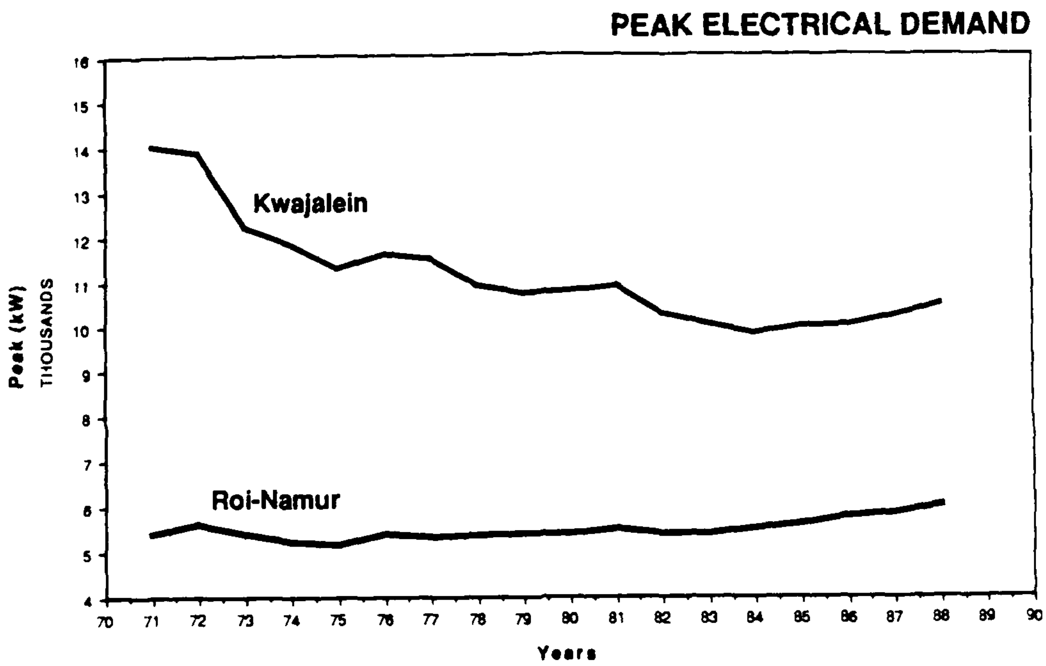
This section describes the visual resources of the USAKA islands that may be affected by the proposed action alternatives. The region of influence for aesthetics includes the islands of Kwajalein, Roi-Namur, Omelek, and Meck--the sites of proposed construction activities that may affect the natural or man-made landscape.

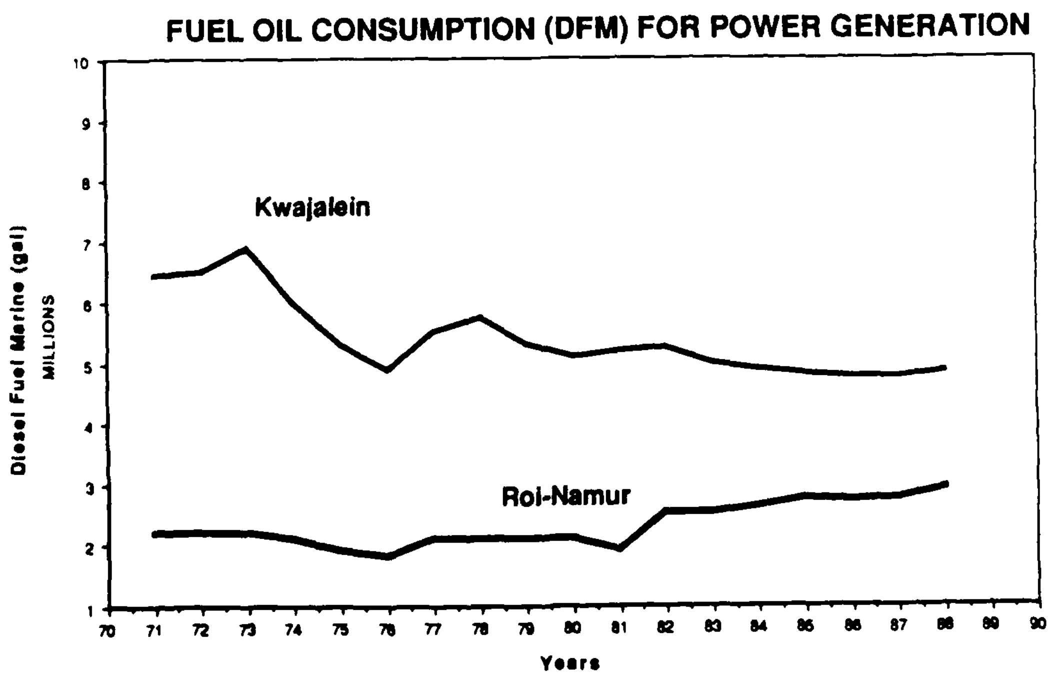
Visual resources can be described in terms of the landscape's visual character and the viewers who perceive the landscape.

The Visual Character of the USAKA Landscape

The USAKA islands have a long history of human occupation and modification and a significant portion of the natural landscape features have been altered or replaced by built structures (see Figures 3.9-4 to 3.9-12).

On the islands of Kwajalein and Roi-Namur, operations and land area constraints require that a wide range of activities takes place in a small area. The proximity of diverse uses results in a variety of building types, forms,





SOURCE: Based on USAKA Monthly Statistics - Electrial (PAN AM World Service, Inc.)

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

ENERGY CONSUMPTION
KWAJALEIN & ROI-NAMUR

Figure 3.12-3

materials, and landscaping, and create a visually heterogenous environment. The landscapes on the two islands vary from built-up industrial zones to areas of man-made greenery and landscaping (e.g., the golf course and lawns). Landscaping for aesthetics purposes is concentrated in housing and community facilities areas on both Kwajalein and Roi-Namur Islands.

As part of the USAKA Master Plan, USAKA recently prepared a report entitled "USAKA Design Guide: Installation Exterior Design Theme and Guidance" (CH2M HILL and Belt Collins and Associates, 1988). The report is intended to guide the design of new construction and landscaping in residential and community support areas on Kwajalein and Roi-Namur.

The views most often seen by residents of Roi-Namur and Kwajalein are those from the areas most frequented by residents: the views from their homes, community facilities, busiest roads, and recreation areas. Areas with more specialized functions, such as some of the utility and communications areas, have fewer viewers.

Meck Island has been used as a missile launch site for several decades. The island is almost entirely altered by mission support facilities. Its visual character is dominated by currently used and deactivated mission support facilities; little vegetation remains.

Omelek Island is now used primarily for meteorological rocket launches. The visual character of the island is mixed: three small stands of native trees are separated by cleared grassy areas within which range support facilities are located.

The two inhabited islands of Kwajalein and Roi-Namur have viewers who could be affected by changes in the visual environment. Currently on Meck and Omelek, the only people likely to be affected by changes in the visual environment are the two security guards on 24-hour shifts.

3.14 RANGE SAFETY

Range safety is defined as measures taken to prevent injury, to protect personnel and the general public, and to minimize damage to property. Range safety at USAKA includes compliance with USAKA operational requirements and federal occupational safety regulations, and use of other reasonable precautions during the preparation and execution of test programs. Other important range safety concerns are the successful completion of test program objectives and the avoidance of incidents that could have international political repercussions.

The following section describes existing ground and flight safety procedures at USAKA. It is based on procedures in effect for operations at USAKA in early 1989, and on the evaluation of procedures used for past test flight programs.

3.14.1 GROUND SAFETY

Ground safety includes formal safety programs and directives to protect USAKA personnel and the public from injury when conducting hazardous or routine operations. Hazardous operations consist of handling and transporting hazardous materials and equipment or performing tasks that pose a risk of injury. Routine operations are activities such as base security that are performed continuously.

The region of influence for ground safety includes the USAKA islands. Several of the islands may be affected by construction; the handling and storage of rocket propellants, explosives, and other hazardous materials; and other potentially hazardous operations.

Kwajalein Island is the center of USAKA operations. Its activities include receiving and storing fuels, propellants, and explosives, and launching meteorological rockets. Kwajalein Island is the site of several construction projects for test programs and general base facilities. Roi-Namur, Meck, and Omelek Islands are, or have been in the past, sites of periodic missile launches and have facilities to store and assemble missile components. On other USAKA islands, construction supports test program activities.

The primary sources of information on ground safety are USAKA ground safety plans for hazardous operations, and regulations such as USAKA 385-75, Explosives Safety. During a field trip to USAKA in March 1989, personnel from the Range Command and Safety Offices were interviewed about the development of safety procedures, the review process for hazardous operation safety plans, explosives and propellant safety, and ground safety plans for test programs.

The adequacy of ground safety programs was evaluated by comparing reported accident information with that of the aerospace industry. The types of accidents and injuries at USAKA were evaluated to determine if existing safety programs adequately address typical operational conditions.

3.14.1.1 Hazardous Operations

Ground safety programs exist to protect USAKA personnel and the public from potential safety or health risks that might result from hazardous operations. Operations that are considered hazardous are reviewed by the USAKA Safety Office to

determine the procedures and precautions to be used in conducting the operation. The scope of hazardous operation review includes industrial safety and compliance with Occupational Safety and Health Act (OSHA) regulations and, for operations involving explosives, USAKA regulations for explosives safety. Accident scenarios are evaluated to determine precautions and emergency team response.

Explosives Safety. Explosives are used at USAKA for construction activities such as quarrying coral rock, and for missile test flight programs. Propellants contained in solid rocket boosters and liquid fuel motors are categorized as explosives, although the majority of propellants do not detonate but are mass-fire hazards. Small amounts of other explosives are used in missile launches for booster stage separation and flight termination systems. Flight termination systems include explosives to destroy in-flight missiles that display abnormal flight characteristics.

Explosives safety at USAKA is regulated under USAKA Regulation 385-75, which is derived from AR 385-64, DOD 6055.9 and DOD 5154-S, Ammunition and Explosives Safety Standards. These standards direct the storage, handling, transportation, and disposal of explosives. Explosives are stored on Kwajalein, Roi-Namur, Meck, and Omelek. Solid rocket booster storage is limited to a single mission set on Roi-Namur, Meck, and Omelek. Additional booster segments are typically kept on the U.S. mainland until needed for a mission, and then stored on Kwajalein for a limited time before the mission.

Missile Components. The propulsion systems for missile launch programs at USAKA typically consist of either a small two-stage meteorological rocket or a two- or three-stage solid rocket motor system with a liquid propellant payload rocket. The solid rocket motors are composed of a fuel, aluminum, and an oxidizer (ammonium perchlorate) in a synthetic rubber binding material. Other chemical compounds are added to modify performance characteristics. The payload rocket is fueled in many programs by monomethyl hydrazine (MMH) and an oxidizer, nitrogen tetroxide (N_2O_4), which are metered into the rocket and ignited in a hypergolic reaction. Freon is used as an alternative liquid propellant in some test flights.

The payloads for both USAKA missile launches and incoming RV missions are experimental instrumentation for the purpose of guidance and data collection. The payloads contain no nuclear devices. Potentially hazardous materials contained in reentry payloads are limited to lithium batteries.

Launch Facilities. The launch facilities on Kwajalein, Roi-Namur, Meck, and Omelek consist of structures for the

storage, assembly, and launch of missiles carrying experimental payloads. The primary structures are MABs, payload buildup buildings, explosive and propellant storage magazines, launch control buildings, and launch pads. These structures are located according to quantity/distance criteria defined in AR 385-64, which also takes into account the hazard class and compatibility of explosive materials.

The site plans of launch facilities are based on separation distance requirements between magazines, operations facilities, public transportation routes, and unrelated inhabited buildings. The site plans for building separation are reviewed and approved by the DOD Explosives Safety Board prior to funding for construction. Waivers for building separation requirements have been approved for magazines on Kwajalein and Roi-Namur, which are near the aircraft runways and golf courses.

The operations buildings at launch areas are constructed to protect personnel from explosion pressures and fragments. During hazardous operations such as missile assembly, the number of personnel allowed in these buildings is limited. A government safety representative is present during all hazardous operations. During launches, nonessential personnel are evacuated from the area. Remaining personnel are required to remain in assigned shelters.

Toxic Substances and Hazardous Wastes. Toxic materials used in hazardous operations include liquid fuels, solvents, and lubricants. MMH and N_2O_4 present fire and toxicity hazards if accidentally released to the atmosphere. MMH is flammable in a wide range of concentrations in air, and is poisonous if inhaled. Nitrogen tetroxide can cause spontaneous combustion of lubricants and other organic materials, and is also an inhalation hazard.

Several USAKA operations produce hazardous wastes consisting of spent solvents, used oils and lubricants, paints and paint thinners, epoxy coatings and adhesives, foam insulation admixtures, and hydraulic fluids. The disposal of hazardous wastes is regulated by RCRA, 40CFR 261-265.

Hazardous materials and waste are discussed in greater detail in Section 3.12 of this DEIS.

Transportation. The transportation of explosives and propellants presents the principle transportation hazard. Explosive materials are first received at Kwajalein Island, either by ship or airplane. Airplane shipments are received at a remote parking area called a "hot spot" (see Figure 3.9-1). Roi-Namur also has a hot spot for air shipments from Kwajalein Island. Explosives and solid rocket motors are moved from the hot spot to magazines near the Kwajalein

runway or to the barge slip ramp (MZ Pier) to be transported to other islands.

Surface vessel shipments of explosive materials are received at Echo Pier on Kwajalein Island. Because Echo Pier is adjacent to a residential area and inhabited base operations buildings, the amount of explosives handled is limited to the criteria established by USAKA Regulation 385-75, Explosives Safety. Quantities in excess of these limits require evacuation to greater separation distances, or are limited by other restrictions.

Ground transportation of explosives on Kwajalein and Roi-Namur is on roadways that avoid populated areas and lead to storage magazines or missile assembly buildings.

3.14.1.2 Accident Risks

Experimental programs at USAKA require completion of a hazards analysis by user organizations or contractors. The purpose of the hazards analysis is to identify potential risks and develop procedures that will prevent accidents. The hazard analysis process includes the design, development, manufacture, testing, and transportation of program elements. The requirements of this process are defined in Military Standard 882-B, Hazard Analysis.

The ground safety plan for each program at USAKA contains emergency procedures that address several potential accident scenarios. For example, the emergency procedures for a missile launch program include the response to misfire and hangfire conditions, an explosion or fire on the launch pad, and the impact of an errant rocket.

An explosion or fire on the launch pad or in a silo could cause an uncontrollable fire that could throw fragments of booster case and propellant for several hundred yards. For this reason, a ground hazard area is established that changes size during various stages of the mission. For example, when the missile is on the launch pad, the ground hazard area restricts personnel access within the area that would be affected by fragmentation.

3.14.1.3 Fire Protection

Fire protection is provided with fire suppression systems in most operations buildings. At Kwajalein and Roi-Namur, fire stations are manned continuously to respond to fires in operations or residential areas. Installations are inspected by the Fire Safety Office for compliance with National Fire Protection Association (NFPA) standards.

The fuel tank farm at Kwajalein has a foam suppression system designed for diesel and jet fuel fires.

3.14.2 FLIGHT SAFETY

The flight safety program consists of formal procedures for the preparation and completion of missions involving aircraft, missile launches, and reentry payloads. The objective of this program is to protect USAKA personnel, inhabitants of the Marshall Islands, and ships and aircraft operating in the area affected by these missions.

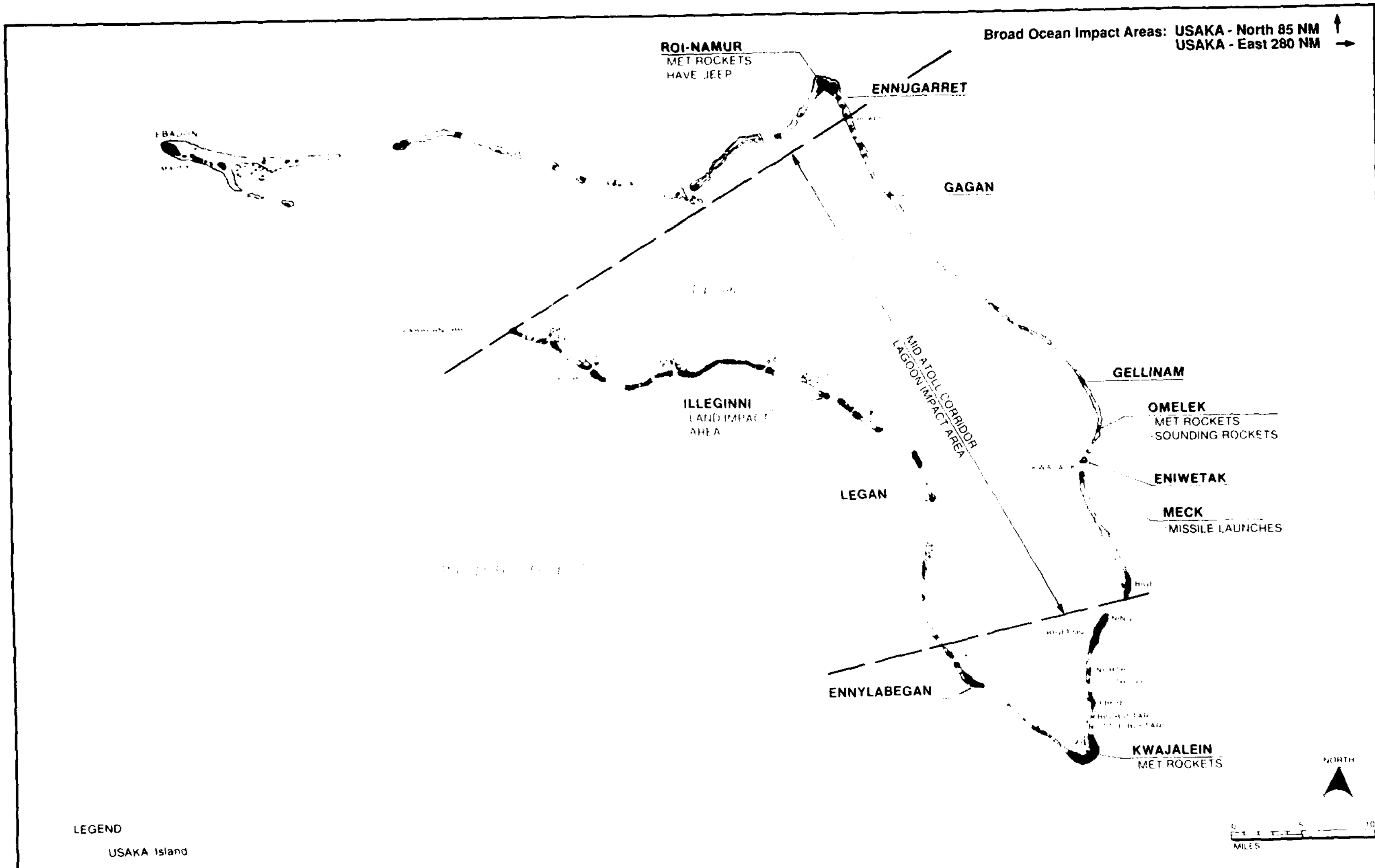
The region of influence for flight safety varies according to the type of mission. For most incoming reentry vehicle missions, the targeted points of impact are within two areas, the mid-atoll corridor and the BOA, as shown in Figure 3.14-1. The islands, lagoon, and ocean in the vicinity of the points of impact are affected by flight safety procedures that include warning messages, evacuation, shelter, and surveillance.

A larger area is affected by missions involving the test flight of ballistic missiles launched from USAKA. The nominal trajectory of these missiles is to the north-northeast of Kwajalein Atoll in the BOA where the lowest number of inhabited islands are located. The debris impact footprint for some test flights extends beyond the Marshall Islands to an area south of Wake Island, as shown in Figure 3.14-2.

The area affected by aircraft missions includes Kwajalein Atoll and an area of up to 100 miles around USAKA. Flight plans are prepared and approved for all aircraft missions. Routine air transportation is conducted under Army, Federal Aviation Administration, and international regulations. During any activities which pose a hazard to aircraft, special procedures, such as Notification To Airmen, are employed to redirect air traffic around affected areas.

The largest region of flight safety influence is for test flight missions involving the collision of a target missile with an interceptor missile launched from USAKA. The collision debris footprint from this type of mission extends laterally from the area affected by a single test flight, as shown in Figure 3.14-3, which is based on the hazard area for the Homing Overlay Experiment, the interceptor missile launched from USAKA during the mid-1980s.

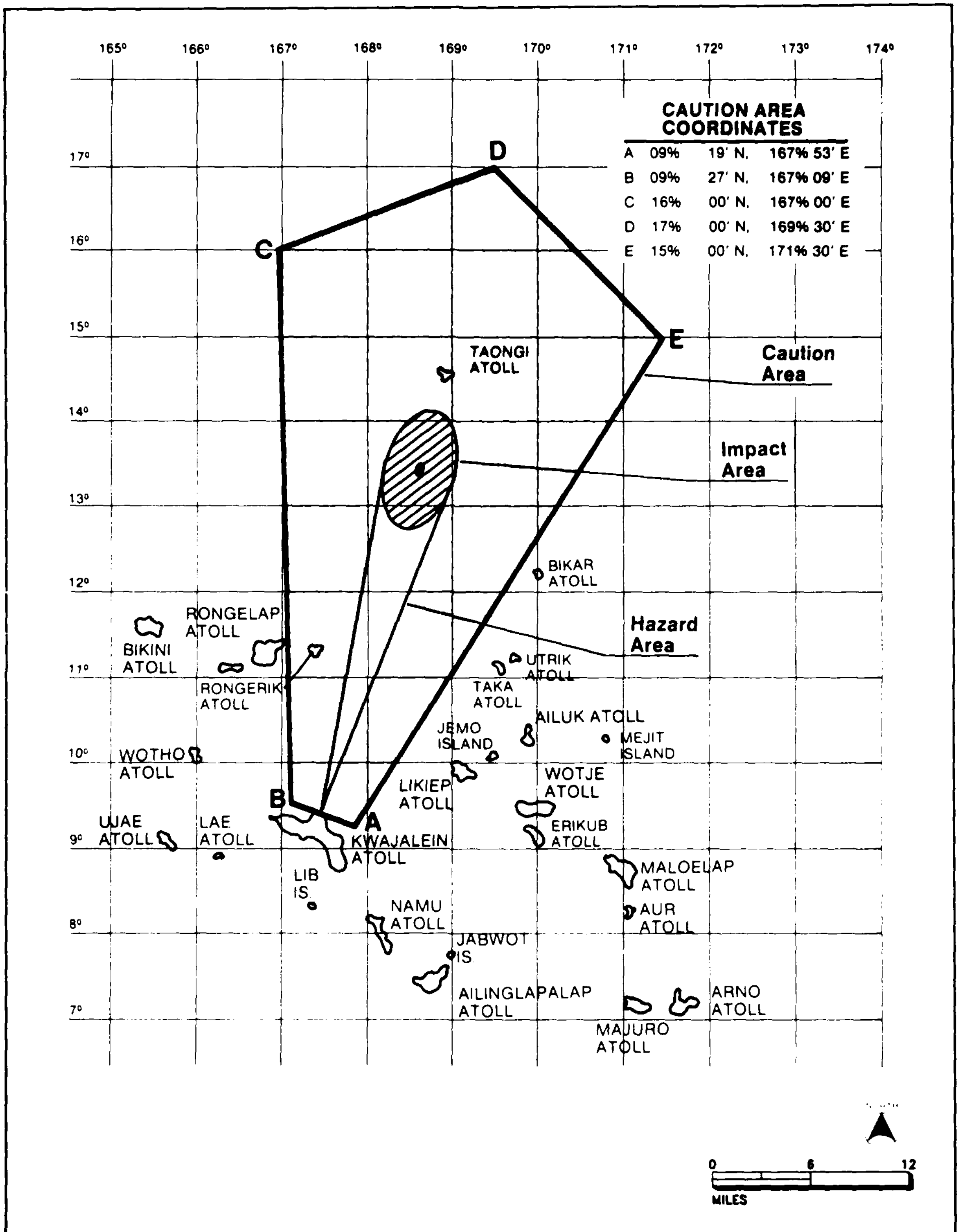
Data sources for flight safety programs include published regulations and directives, and flight plans for specific reentry vehicle, ballistic missile, and interceptor test flight missions. During a field trip to USAKA in March 1989, personnel from the Range Command and Safety Offices



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

LOCATION OF LAUNCH FACILITIES AND RE-ENTRY VEHICLE IMPACT AREAS

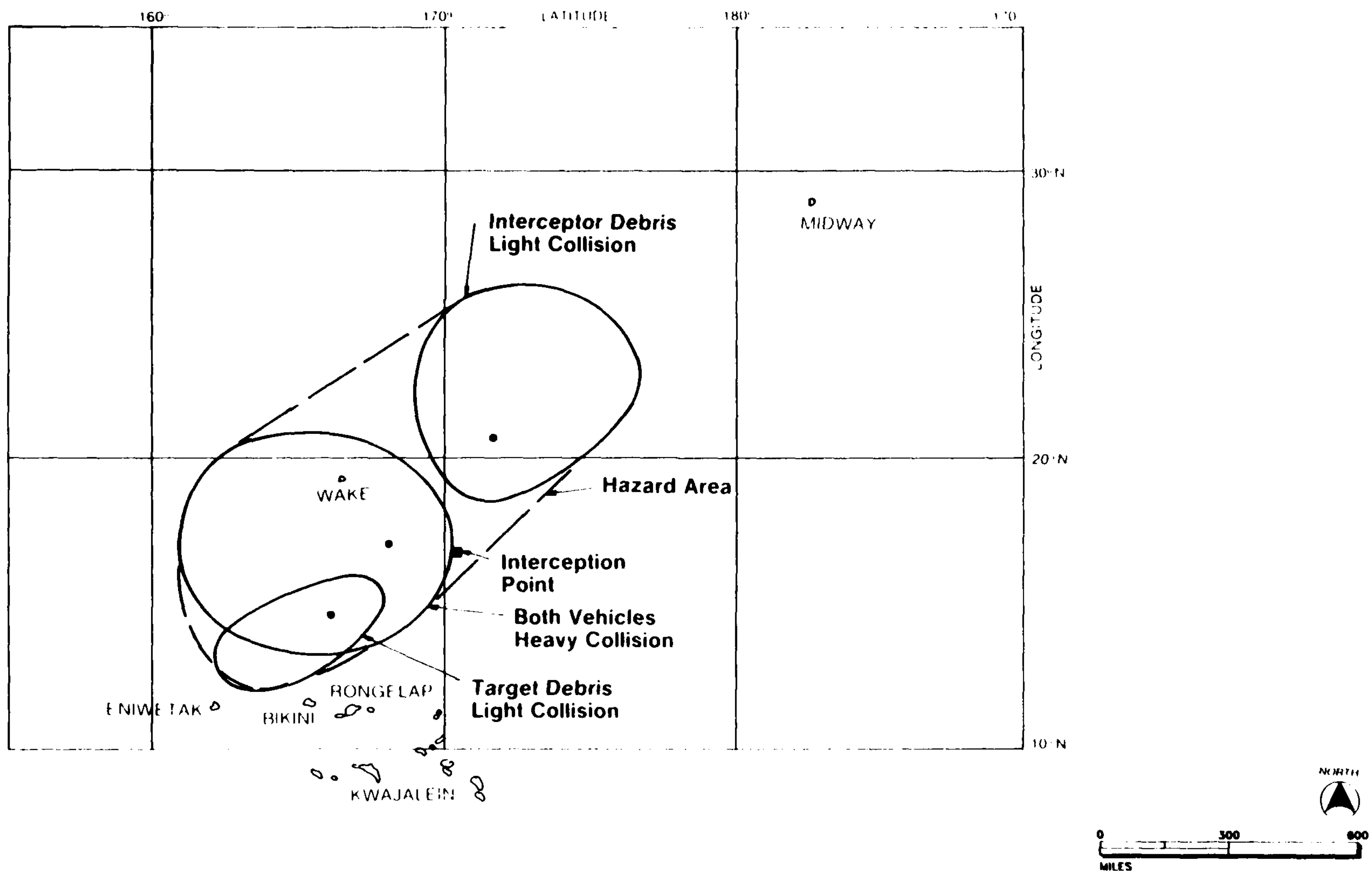
Figure 3.14-1



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

BALLISTIC MISSILE TEST FLIGHT RANGE SAFETY HAZARD AREA

Figure 3.14-2



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ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

INTERCEPTOR TEST FLIGHT RANGE SAFETY HAZARD AREA (HOMING OVERLAY EXPERIMENT)

Figure 3.14-3

were interviewed regarding the development of safety procedures, the review of flight safety plans, and the implementation of Range Safety System procedures.

3.14.2.1 Mission Preparation

Flight Safety Plan. Pre-mission flight safety activities include evaluating risks to people and property in the intended flight path, determining safety support system requirements, calculating trajectory and debris footprints, determining range clearance requirements, and designating the flight termination system. These activities are summarized in a flight safety plan. The flight safety plan includes notification of inhabitants and air and sea traffic in the caution area designated for the specific mission.

A flight safety plan is used for both missile launches and incoming RV missions. Reentry payloads are launched from Kwajalein, Roi-Namur, Meck, and Omelek Islands. RVs are launched from the Western Space and Missile Center (WSMC) at Vandenberg Air Force Base, California, and the Pacific Missile Range Facility (PMRF) at Barking Sands Airfield, Kauai, Hawaii.

Several technical requirements are specified in the flight safety plan, including obtaining frequent meteorological data before and during a mission, calculating and correcting launcher elevation and azimuth settings, and testing range safety instrumentation and radars.

Notification. Warning messages are transmitted to appropriate authorities to clear caution areas of ship and aircraft traffic and to inform the public in the area of USAKA mission activities. The warning messages contain information describing the affected area, stating the hazard time interval, and suggesting safe alternate routes.

A NOTAM, or notice to airmen, is issued to the Federal Aviation Administration in Honolulu at least 48 hours before a mission. An FAA hazard warning is sent to the Central Altitude Reservation Facility, in Washington, D.C., and the Oakland Air Route Traffic Control Center 7 days before a mission. HYDROPAC and CINCPACFLT messages are sent out to alert ship traffic 5 days before a mission.

A message is sent to the government of RMI in Majuro 2 days in advance. Announcements are made on USAKA base radio, on the Ebeye ferry, and on Armed Forces Radio Station Kwajalein for 2 days before a mission. The USAKA newspaper also carries a published notice for 2 days.

3.14.2.2 Launch and Reentry Missions

Range Clearance and Sheltering. Prior to launch or RV missions, specific areas that may be hazardous are evacuated or have sheltering requirements. For launches from Roi-Namur, for example, personnel not essential to the mission are required to take shelter at one of two facilities shortly before the launch. Similar shelter facilities are designated for Ennubirr.

Launch missions have a hazard area around the nominal point of impact where the dispersion of RVs and debris requires that personnel not essential to the mission be evacuated and that ships and aircraft be cleared. When the hazard area includes islands, the islands are called debris hazard islands.

Launch missions of an interceptor missile involve a larger hazard area, as in the example of the Homing Overlay Experiment (HOE), shown in Figure 3.14-3. An interceptor mission generates more debris in a less predictable pattern, resulting in a circular hazard area that represents the collision debris footprint.

Within a hazard area, an island that has an unacceptably high probability of impact by a payload, missile stage, or other debris is completely evacuated.

A caution area is a larger area around a hazard area, as shown in Figure 3.14-2. Precautions taken in the caution area include evacuation of personnel not essential to the mission, sheltering remaining inhabitants, and notification of ships and aircraft by warning messages issued several days before missions.

The caution area for launch missions such as the HAVE-JEEP program may extend beyond the Marshall Islands to an area south of Wake Island. This launch program has a north-northeast trajectory to avoid inhabited islands. Two atolls remaining in the caution area, the Rongerik and Taongi Atolls, receive aircraft surveillance.

Sheltering is required during RV missions impacting in the mid-atoll corridor. The mid-atoll corridor is defined as the area between the reef islands on the east and west, and by a line north of Boked Island on the east and Yabbernohr Island on the west, and a line south of Bigej Island on the east and north of Ninni Island on the west. The mid-atoll corridor is declared a caution area when it contains the point of impact, and personnel not essential to the mission are evacuated, with the remaining inhabitants required to move to approved shelters. In the mid-atoll corridor, Meck and Ennylabegan have approved shelters.

Range Safety Instrumentation. Flight safety at USAKA includes range safety instrumentation that provides instantaneous information on the status of airborne vehicles and the area around USAKA. The Kwajalein Range Safety System (KRSS) was recently upgraded to provide better information by linking the radar systems at USAKA to the range safety center on Kwajalein. A missile launch or RV can be accurately tracked during its entire flight by the tracking display system.

Guided missiles launched from USAKA are equipped with flight termination systems, which allow destruction of the missile if certain criteria are met or, in the opinion of the flight safety officer, if the missile poses a hazard to personnel or property. A typical criterion for flight termination is when the missile footprint intersects a Marshall Islands protection circle, an artificial boundary placed around inhabited atolls and islands.

3.15 ELECTROMAGNETIC RADIATION ENVIRONMENT

The area of concern is the potential hazard to humans and native fauna that could result from electromagnetic radiation (EMR) as well as interference caused by EMR. Electromagnetic radiation is emitted from the USAKA radars and communications equipment. USAKA radars can be operated individually or in combination to produce higher radiation intensities in the far field than can be achieved by single radar operation.

Communications equipment is generally of lower radio frequency, lower emitted power, and fixed direction; this produces a minimal hazard threat.

Electromagnetic radiation can be divided into two general types: ionizing and non-ionizing. Ionizing radiation consists of alpha, beta, gamma, neutron, and X-ray. The ionizing radiation hazard is controlled by:

- Identifying emission sources such as X-ray equipment and high voltage areas
- Emission shielding
- Limiting access to essential trained personnel
- Use of accumulated dose indicator badges

Because this hazard source is very limited and rigorously controlled, it is not considered an environmental threat and is not further discussed.

The nonionizing radiation (radio frequencies in the range between 10 kHz and 300 GHz) can be a hazard. Empirical testing of physical reactions to radiation exposure shows body heating with potential localized eye injury. This testing has provided data to establish a safe or Permissible Exposure Limit (PEL) of 0.4 Watt per kilogram (W/kg) averaged over a 6-minute period, which includes a safety factor of 10. This PEL is defined in DOD Control Instruction No. 6055.11, "Protection of DOD Personnel from Exposure to Radio Frequency Radiation," in U.S. Army Hygiene Agency Technical Guide No. 153, "Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation," and in USAKA Regulation 385.3.

Hazard zones are defined to preclude human exposure to energies greater than 0.4 W/kg. These zones are based on the frequency, power output, height, and beam characteristics for each transmitter. Two zones have been established at differing power densities to account for the greater sensitivity of people who are shorter than 140 cm (55 inches) (American National Standards Institute [ANSI] C95.3) to RF at frequencies above 100 MHz. The zones for frequencies above 1,000 MHz are defined by:

- 5 milliwatts per square centimeter (mW/cm^2) for persons less than 55 inches in height ("restricted area")

- 10 mW/cm^2 for persons taller than 55 inches ("unrestricted area")

Hazard zones are shown in the figures in this section as circles centered on the emitter. In actual operation, the zone exists only in the direction that the antenna is pointed. A circle is shown because, theoretically, the antenna could be pointed in any direction. In actual practice, radars have soft stops and mechanical stops that prevent them from rotating 360 degrees.

Except when radars are operated at inclinations less than zero degrees, the hazard zone does not extend down to ground (or water) surface. The typical hazard-free zone exists from the surface to 15 feet or more, depending on the radar.

Radar operations personnel were interviewed to obtain documents and information on radar site descriptions, operating scenarios, and radiation hazard areas.

The computer program used in the analysis of the USAKA radars for this EIS is based on the early work of R. W. Bickmore and R. C. Hansen (1959) on antenna power densities in the near field. A Southwest Telecommunication Computer Program, "Radiation Hazard-B," was used to independently produce radiation hazard plots for each of the radar

systems. Another computer program, "Numerical Electromagnetic Code," capable of producing similar results, was obtained from Ohio State University Electromagnetic Laboratory to provide additional information for correlation checks. The radio frequency (RF) radiation hazard criteria used in evaluating each of the radars is shown in Table 3.15-1.

3.15.1 DEFINITION AND ANALYSES OF USAKA EMITTERS

The RF sources on USAKA are radar installations, microwave communication stations, and other communications equipment that emit electromagnetic radiation. USAKA Regulation 385-3 (January 1989) governs emitters sufficiently to avoid hazardous conditions.

There are currently 14 identified sources of microwave and RF energy on Kwajalein Island, 5 sources on Roi-Namur, and 3 sources on the mid-atoll islands. Each source has hazard zones as defined in USAKA Regulation 385-3 that are controlled to prevent the source from radiating other radars and buildings.

RF power density surveys are conducted to ensure realistic hazard zone definition and compliance with range safety criteria. Two types of surveys are performed at USAKA:

- Special--conducted whenever a location change or operational modification occurs

- Walk-through--periodic assessment of hazard criteria and operational mitigation controls

Procedures have been established at USAKA to ensure that all incidents involving significant exposure to RF radiation are investigated. All incidents involving exposure to five times the PEL or greater require measurement, physical examination, and formal reporting.

3.15.1.1 Kwajalein Island

There are eight high-frequency (HF) antennas on the northwest tip of Kwajalein Island near Building 1500. Each antenna is within a fenced area. A building height restriction of 11 meters (36 feet) above the ground has been established to avoid exposing inhabitants to hazardous EMR.

There are three sources of microwave emissions: the Command Control Transmitter (two antennas), which has a hazard area radius of 112 meters (367 feet) and a lower height limit of 4.3 meters (14 feet); the AN/FSC-78 Satellite Communications Transmitter, with radiation hazards confined to the interior of the radome; and the Global Positioning System, for which the radiation hazards are also confined to the interior of the radome.

	ALCOR	ALTAIR	TRADEX	MMW	AN/FPQ-19	AN/MPS-36	SDRs
Center Frequency, GHz	5.672	.1555 .422	1.32 2.9508	35 95.5	5.65	5.65	9.375
Transmit Power							
Peak, MW	2.5	7.0 5.0	2.0 2.0	.014 .003	2.8	1.0	.5
Average, kW	9.0	110 250	150 30	1.4 0.3	2.24	1.0	.22625
Antenna							
Type	Paraboloid	Paraboloid	Paraboloid	Paraboloid	Paraboloid	Paraboloid	Shaped Parabola
Diameter, m	21.1	45.7	25.6	13.	8.8	3.7	~1.6
Gain, dBi	55	34.7 42.4	48.2 54.2	70.1 77	53	43	41
BdB Beamwidth, mrad	10.4	97.7 38.4	21.2 10.2	0.76 0.29	7	20.9	$\Delta Z = .6^\circ$ $EL = 2^\circ$
1st Sidelobe dB peak	-20	-19 -19	-17.9 -17.7	-16 -8	-17	-17	–
Radiation Hazard							
$R = 2D^2/\lambda$, m	5540	21.67 5880	5771 12,901	43,825 119,578	2919	516	~163
Transition Point PD	.738	.550 1.0	2.368 .377	.06 .01	1.677	0.596	0.85
R(PD = 10mW/Cm²), m	1354.8	1269[1] 2790[3]	2737.6 1780.8	* *	- -	109.4	43.6
R(PD = 5mW/Cm2), m	2035.4	1593[2] 4928[2]	4195.5[4] 3200	* *	600	168.2	64.8
Elevation Angle Limit	0 Degree	1 Degree	0 Degree	0 Degree	Minus 1 Degree	Minus 1 Degree	0 Degree
Antenna Height, m	7.6	27.4	26.25	18	47	4.3	33.5
Radar Clear Zone, m	4.3	4.3	4.3 (+2°)	4.3	4.3	4.3	–

Notes
1: PD = 1.55 mW/cm²
2: PD = 1.0 mW/cm²
3: PD = 4.22 mW/cm²
4: PD = 4.4 mW/cm²
PD = Power Density

* No Hazard observed with present transmitted power level.

Table 3.15-1
USAKA RADAR CHARACTERISTICS

Three radar systems with imposed hazard restrictions are operated on Kwajalein Island. The radar systems are the AN/MPS-36, the AN/FPQ-19, and the WRS-74S weather radar.

The AN/MPS-36 C-band general-purpose instrumentation tracking radar consists of a 3.7-meter-diameter paraboloid antenna and microwave system, an electronics van, a maintenance van, and a boresight tower. Pertinent system information is shown in Table 3.15-1.

Analysis of the AN/MPS-36 radar using a frequency of 5.65 GHz and PEL levels of 5 and 10 mW/cm² for the non-restricted and restricted areas, respectively, resulted in hazard radii of 168 and 109 meters (551 and 358 feet), which are shown in Figure 3.15-1. The lower value corresponds closely with the 106-meter hazard radius defined by USAKA (9 January 1989). Within this radius, a nonhazardous zone (less than 5 mW/cm² power density) exists from ground level to 4.3 meters (14 feet).

The AN/FPQ-19 Radar System is a highly accurate, long-range, C-band amplitude comparison, monopulse radar. It is capable of manual or automatic RF or optical tracking. The pertinent system information is shown in Table 3.15-1. USAKA Regulation 385-3 shows a 5-mW/cm² nonrestricted hazard range of 600 meters (1,968 feet). No radius is given for the 10-mW/cm² exposure level. This is because the regulation imposes a power limitation of 2.24 kW (average), although the radar has a 9-kW (average) capability. Operation of the AN/FPQ-19 imposes a structural height limitation of 4.3 meters (14 feet) above the mound at the transmitter. The zone of safe exposure extends from the ground to 30 meters (98 feet) within a 600-meter (1,968-foot) radius (Figure 3.15-1).

The AN/FPQ-19 radar is sometimes used to detect RV splashdown. In these instances, the beam elevation is depressed below zero degrees. At an inclination of minus one degree, the beam axis intersects the water surface at 2,266 meters (1.4 miles). At this point, its power density is 1.0 mW/cm² (one-fifth the permissible level for human exposure).

The WRS-74S weather radar, located on the golf course, is low powered and has a small hazard zone. The 5-mW/cm² hazard zone begins 4.3 meters (14 feet) above ground surface and extends to a radius of 51 meters (167 feet).

3.15.1.2 Roi-Namur Island

The major sensors of the Kiernan Reentry Measurements Site (KREMS), located on Roi-Namur, provide USAKA with the capability to perform reentry measurements using a wide range of radar sensors. These sensors are designated ALTAIR (ARPA-Long Range Tracking and Instrumentation Radar), ALCOR (ARPA-

Lincoln C-band Observables Radar), TRADEX (Target Resolution and Discrimination Experiment), MMS (Multistatic Measurements System), and MMW (Millimeter Wave Radar). Along with the KREMS, a windfinding radar is located on Roi-Namur Island. Of these sensors, ALTAIR, ALCOR, TRADEX, and MMW have RF hazard zones defined in accordance with the appropriate PEL shown in Table 3.15-1.

The ALTAIR is a very large aperture VHF/UHF radar that was designed and developed to gather coherent data on reentry vehicles and satellites. The 45.7-meter-diameter antenna employs a focal point VHF feed and a Cassegrain UHF feed and can provide monopulse tracking at either frequency. ALTAIR has "hot spots" within a radius of 213 meters (700 feet) of the antenna that exceed the PEL when certain conditions occur at the same time. In response to this, special precautionary measures have been established to advise personnel passing through the area to remain on the road and not to loiter. Except for the hot spots, no radiation hazard exists from ground level to a height of 4.3 meters (14 feet). The ALTAIR characteristics are in Table 3.15-1.

The ALTAIR radar was analyzed using both VHF and UHF databases. As shown in Table 3.15-1, the PELs for the VHF case are 1 and 1.555 mW/cm^2 for nonrestricted and restricted areas, respectively, and result in hazard distances of 1,593 meters and 1,269 meters (5,227 feet and 4,164 feet), respectively (Figure 3.15-2).

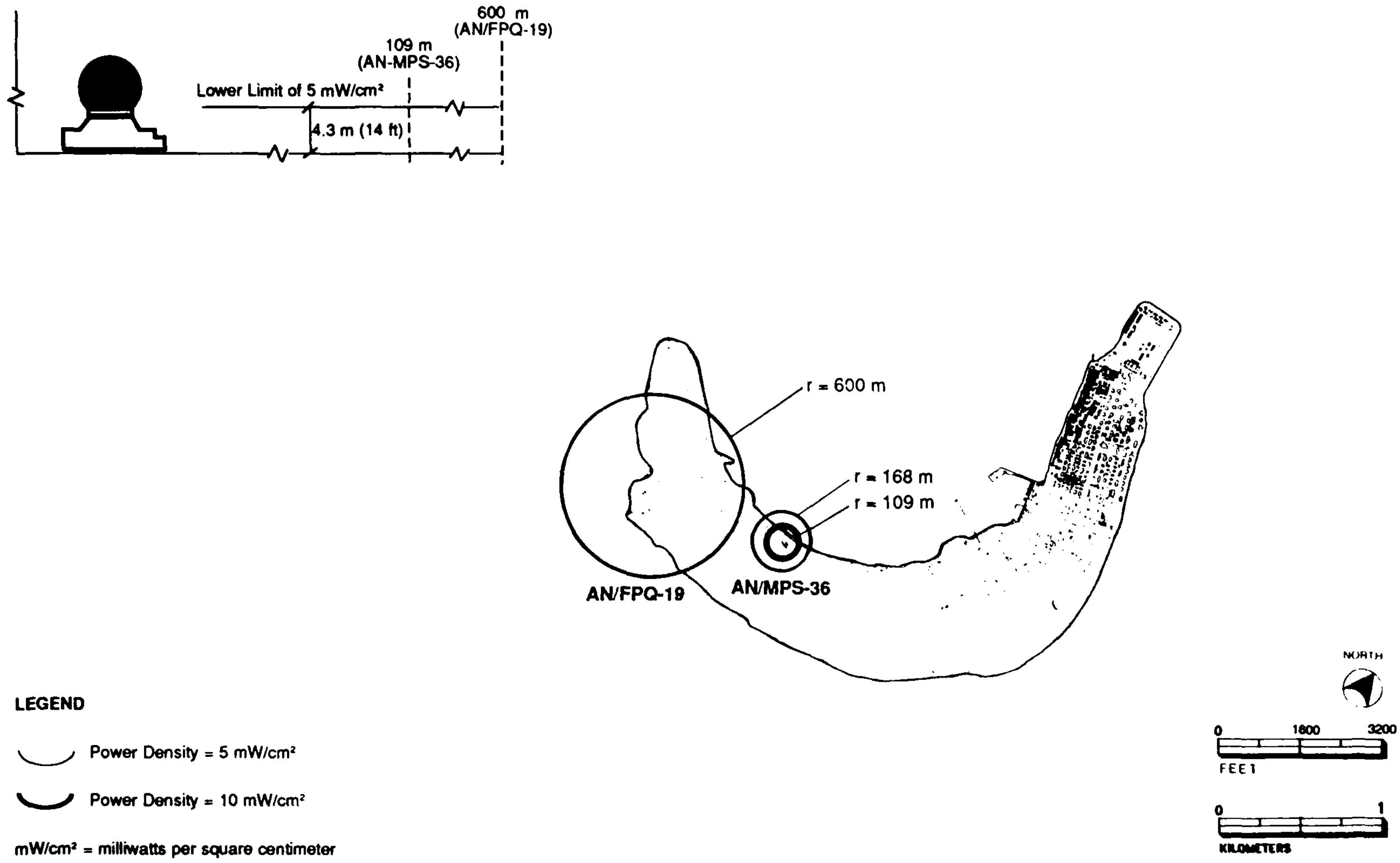
The PELs for the ALTAIR UHF case are 1.407 and 4.22 mW/cm^2 for the nonrestricted and restricted areas, respectively, and result in hazard radii of 4,928 meters and 2,790 meters (16,169 feet and 9,154 feet), respectively (Figure 3.15-3).

The ALCOR is a high-power, narrow-beam, C-band, monopulse tracking radar with narrowband and wideband operating modes, each having separate signal designs. Pertinent information is shown in Table 3.15-1.

Analysis of the ALCOR radar using an operating frequency of 5.672 GHz and PEL levels of 5 and 10 mW/cm^2 for nonrestricted and restricted areas, respectively, resulted in generation of hazard radii of 2,035 meters and 1,355 meters (6,677 feet and 4,446 feet) as shown in Figure 3.15-4. No hazard exists from ground level to a height of 4.3 meters (14 feet) when the zero degree elevation limit is not bypassed.

TRADEX is the initial major sensor of the KREMS program and features an L-band tracker and an S-band illuminator. Pertinent information is shown in Table 3.15-1.

Analysis of the TRADEX radar using a frequency of 1,320 and 2,950.8 MHz was performed with PEL levels of 4.4 and



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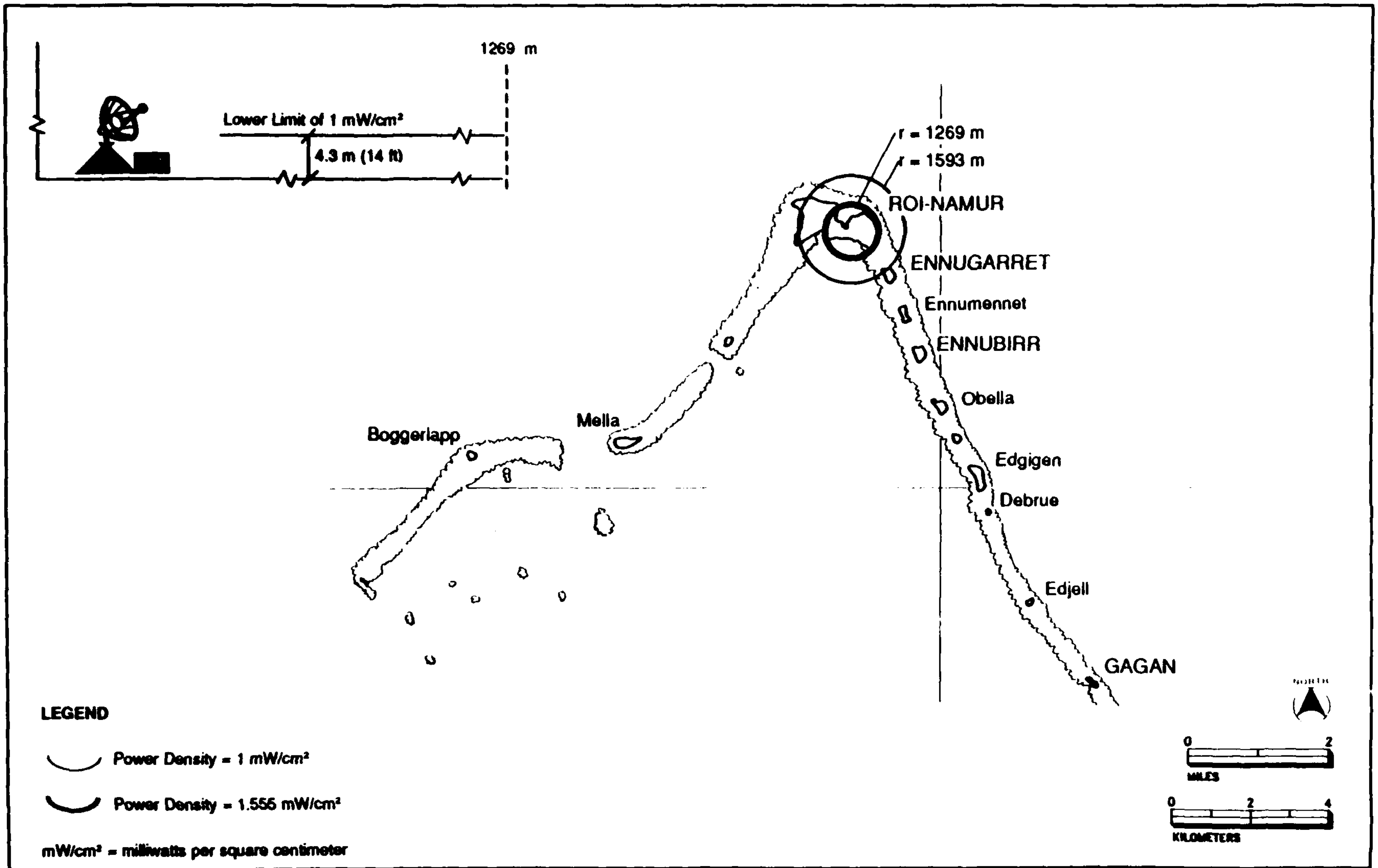
AN/MPS-36 AND AN/FPQ-19 RADIO FREQUENCY RADIATION HAZARD

Figure 3.15-1



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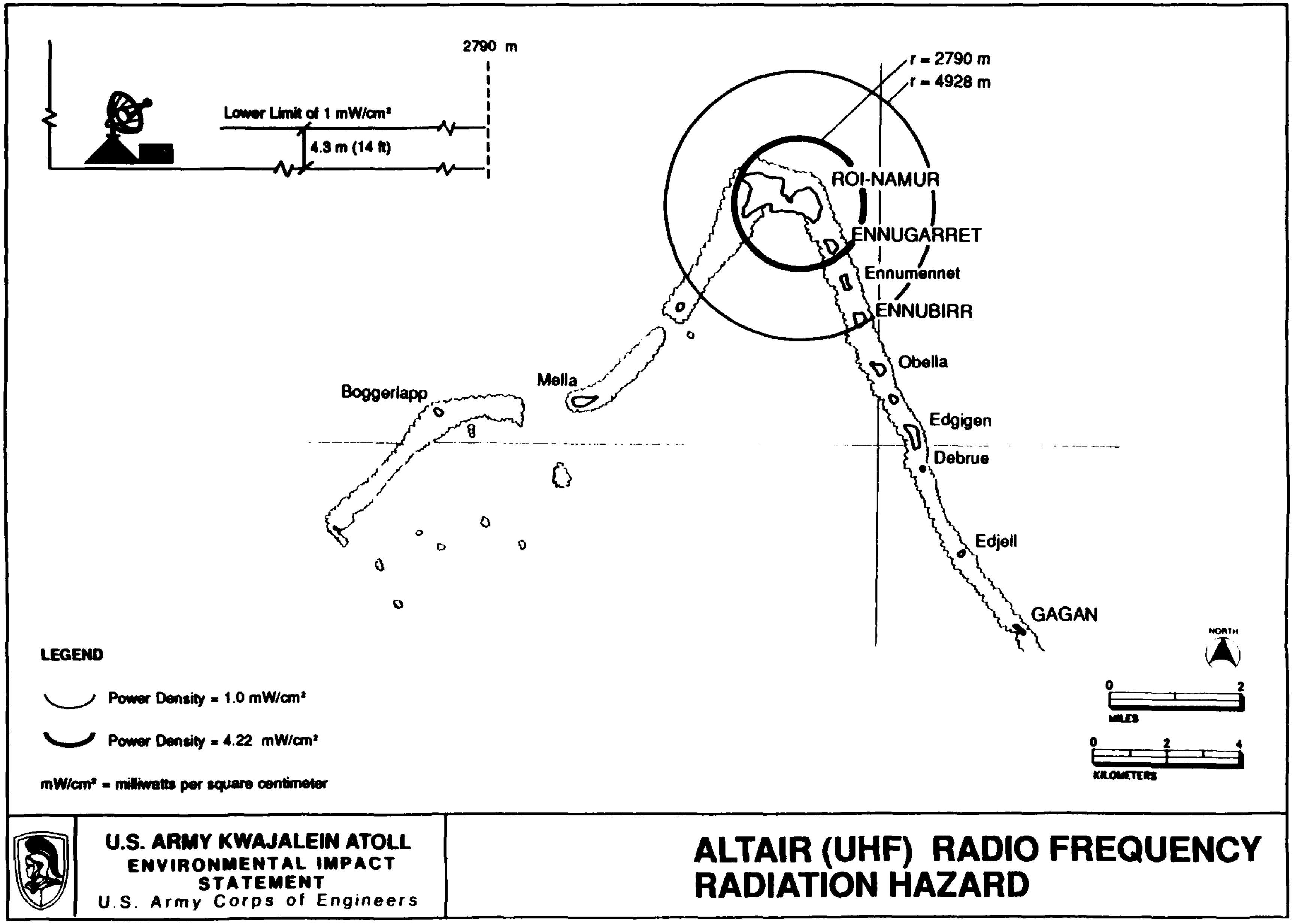
ALTAIR (VHF) RADIO FREQUENCY RADIATION HAZARD

Figure 3.15-2


2790 m
Lower Limit of 1 mW/cm²
4.3 m (14 ft)
r = 2790 m
r = 4928 m
ROI-NAMUR
ENNUGARRET
Ennumennet
ENNUBIRR
Obella
Edgigen
Debrue
Edjell
GAGAN
Mella
Boggerlapp
NORTH
0
2
MILES
0
2
4
KILOMETERS
LEGEND
Power Density = 1.0 mW/cm²
Power Density = 4.22 mW/cm²
mW/cm² = milliwatts per square centimeter
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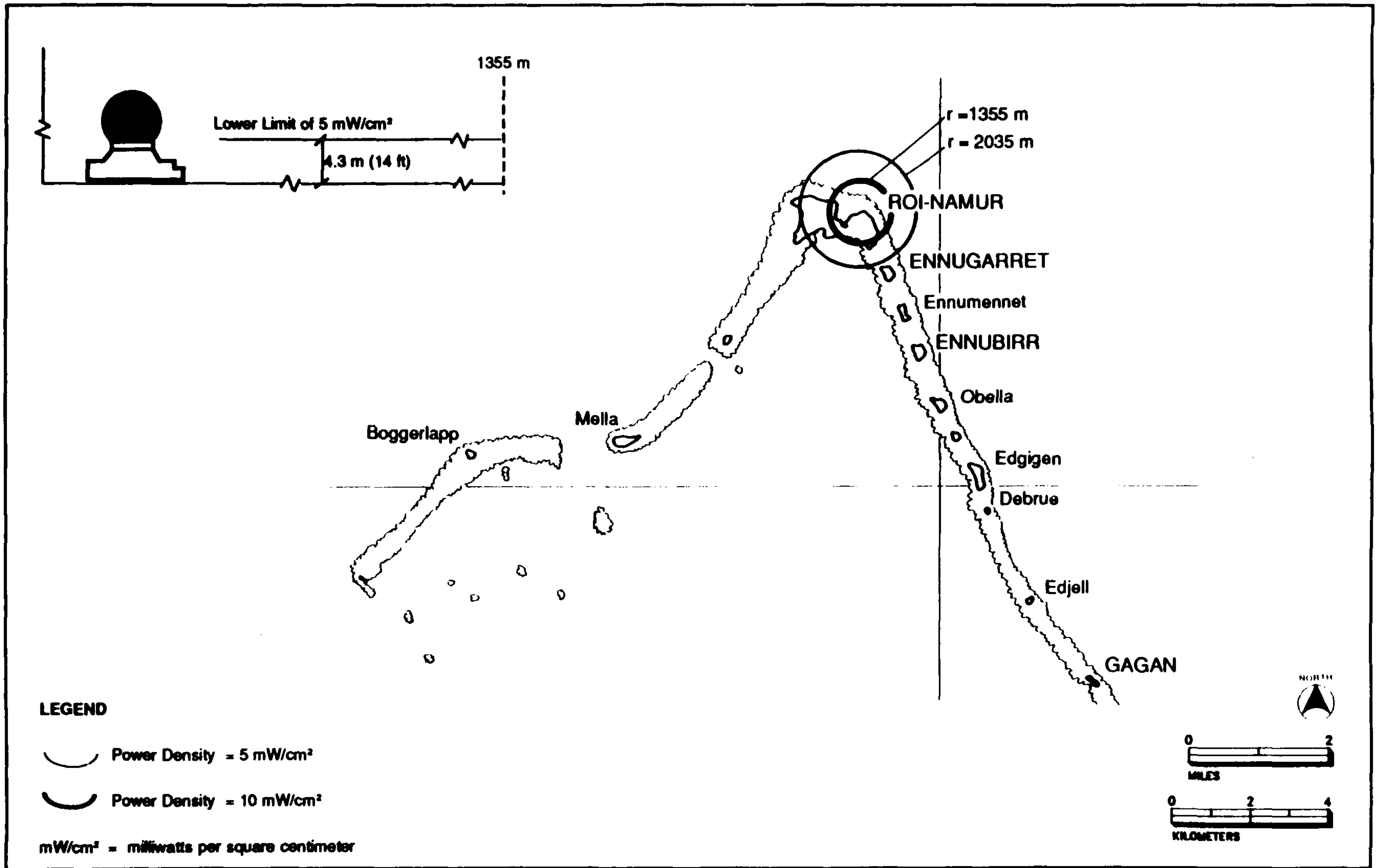
RADIATION HAZARD

Figure 3.15-3



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ALCOR RADIO FREQUENCY RADIATION HAZARD

Figure 3.15-4

10 mW/cm² for the L-band and 5 and 10 mW/cm² for the S-band for nonrestricted and restricted hazard areas, respectively. The results are shown in Figures 3.15-5 and 3.15-6.

The computed distances for the TRADEX nonrestricted and restricted L-band radiation hazard area radii are 4,196 meters (2.6 miles) and 2,738 meters (8,983 feet), respectively. The companion S-band radiation hazard radii are 3,200 meters and 1,781 meters (2 miles and 1.1 miles), respectively. A comparison of the computed radiation hazard regions for the TRADEX with those given in USAKA Regulation 385-3 shows a deviation from the trend observed during analysis of other radars in the USAKA complex. Typically, the computed values tended to be slightly higher or comparable. The USAKA Regulation 385-3 radiation hazard radii for nonrestricted and restricted PELs are 26.9 and 34.9 percent higher than the computed values. It is apparent that the TRADEX hazard radii in the regulation are conservative and are found to be functionally satisfactory using existing mitigation practices. No radiation hazard exists between ground level and a height of 4.3 meters (14 feet) as a result of interlocks restricting TRADEX to not less than a 2-degree inclination. Special restrictions are invoked if TRADEX is operated below the 2-degree limit.

The MMW radar is a dual frequency (K- and W-band) monopulse tracking radar characterized by high-range and Doppler resolution. This radar features high sensitivity, precise pointing and tracking waveform flexibility, and a high degree of computer control of real-time radar operations and signal processing. The radar's 35-GHz band is used for target acquisition, range and angle tracking, and high-resolution data reception, while the 95.5 GHz bank is used for wideband data reception only (i.e., not for tracking). Pertinent characteristics of the MMW radar are shown in Table 3.15-1.

The MMW radar is mounted at an elevation of 18 meters above the ground. With PEL levels of 5 and 10 mW/cm² for nonrestricted and restricted areas, respectively, no hazard exists from ground level up to a height of 18 meters at both operating frequencies of 35 and 5.5 GHz. Above 18 meters, the highest intensity is calculated at 2.5 mW/cm², well below the 5 mW/cm² standard, except in a few hot spots close to the radar, where levels may be higher. Therefore, the MMW radar poses no hazard to personnel.

The windfinding radar hazard is confined to its radome.

3.15.1.3 Mid-Atoll Islands

The Mid-Atoll Islands have three major sources of electromagnetic radiation: the Splash Detection Radars (SDRs)

deployed on Gellinam and Legan, and the AN/MPS-36 radar on Illeginni.

The SDRs are X-band scanning radar systems designed to detect the splash of an RV as it impacts the water surface. The SDR antenna is mounted atop a 33.5-meter (110-foot) tower to provide an unobstructed view for a 360-degree radar scan pattern. The pertinent SDR system is given in Table 3.15-1.

Analysis of the SDRs using an operating frequency of 9.375 GHz and PEL levels of 5 and 10 mW/cm² for nonrestricted and restricted areas, respectively, resulted in identification of radiation hazard radii of 65 meters (213 feet) and 44 meters (144 feet). The restrictions are applicable only to the on-axis region of a fixed-direction antenna. During scanning, radiation intensities do not reach hazardous levels.

The AN/MPS-36 radar on Illeginni Island is identical to a sister radar on Kwajalein Island. The calculated radiation hazard distances are 168 meters and 109 meters (551 feet and 357 feet) for PEL levels of 5 and 10 mW/cm², respectively. The hazard does not exist below 14 feet aboveground. Refer to discussion of radiation hazards on Kwajalein Island for a detailed description.

3.15.2 SIMULTANEOUS RADAR TRACKING OPERATIONS

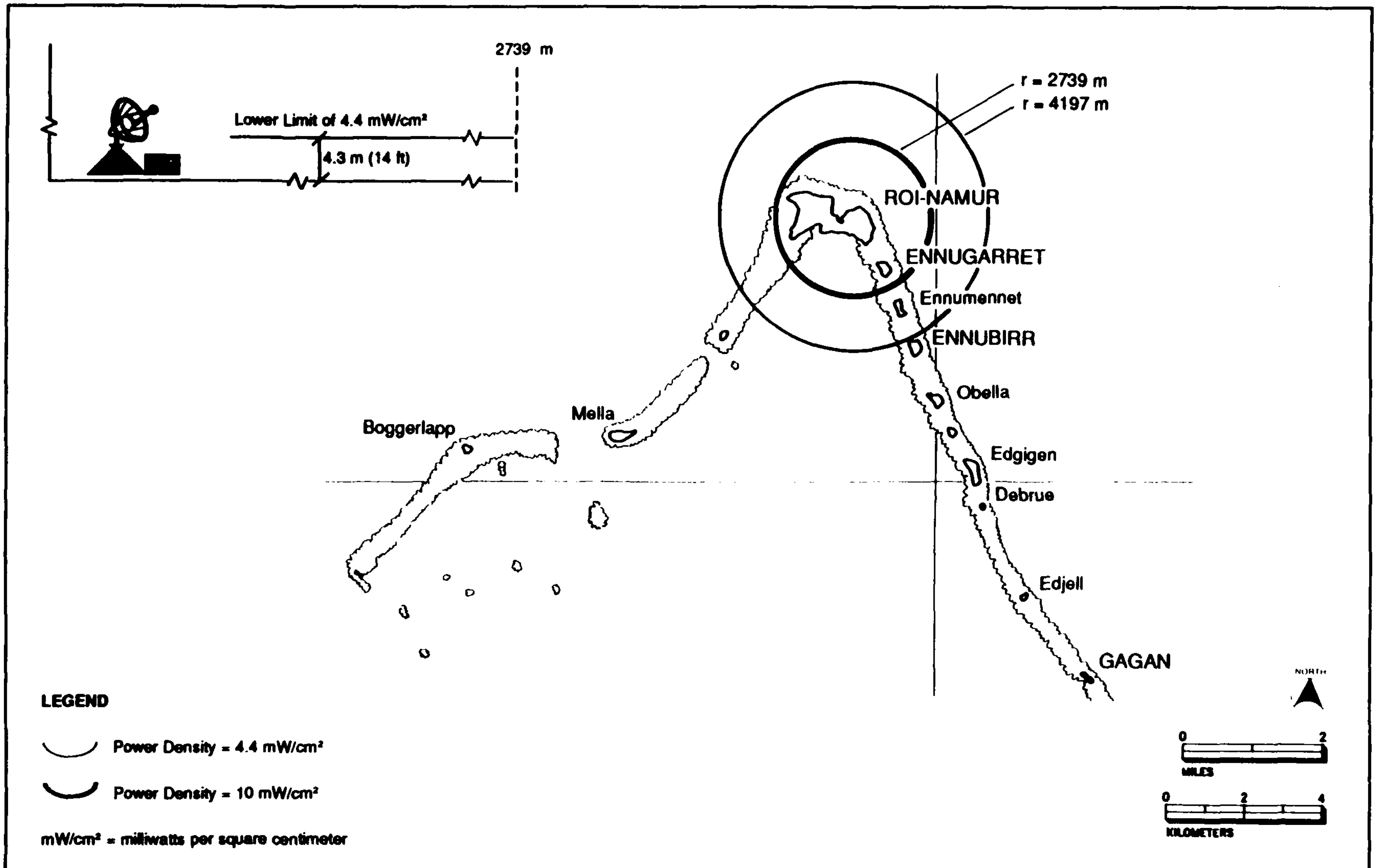
The potential for multiple radar tracking operations to interreact and, thereby, modify the defined radiation hazard distances was assessed.

During normal operations the tracking radars on Kwajalein, Roi-Namur, and Illeginni are activated and track a common target. In the process radar "beams," much like search lights in the near field, may merge. This merging of the beams results in additive power and may distort the customary circular radiation hazard distance.

The operational use of a radar could preclude track continuation into the near field; however, there still could be instances where tracking of independent targets could result in the crossing of the beams. Such a beam crossing would increase the power density in the common volume. Beam crossing is a remote possibility and would not, in any case, affect any areas below the clear area 4.3 meters in height aboveground.

3.15.3 ELECTROMAGNETIC INTERFERENCE

Interference with aircraft instrumentation is avoided in a variety of ways, depending on the particular radar. The TRADEX radar has a computer-controlled inhibited sector of



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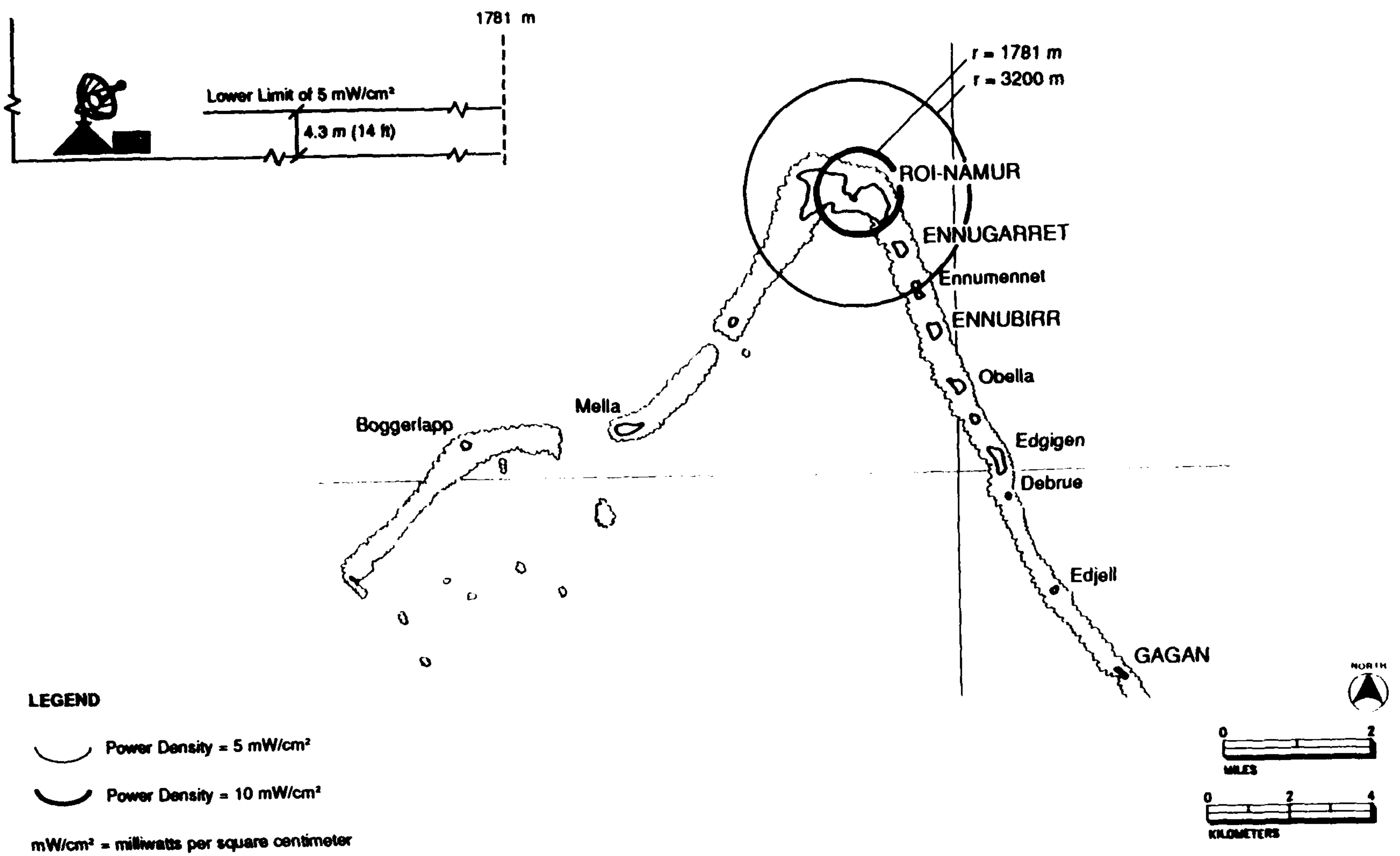
TRADEX (L BAND) RADIO FREQUENCY RADIATION HAZARD

Figure 3.15-5



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TRADEX (S BAND) RADIO FREQUENCY RADIATION HAZARD

Figure 3.15-6

240 degrees clockwise to 40 degrees with an elevation of zero to 15 degrees. The ALTAIR radar will not radiate in excess of 112-kW-average output power during periods when aircraft are approaching, landing, or departing Roi-Namur. It maintains an inhibited sector of 217 degrees clockwise to 24 degrees with an elevation of zero to 13 degrees. The ALCOR and AN/FPQ-19 radars are prohibited from tracking aircraft. However, routine landings and departures are permitted within their hazard zones without negative effects. The splashdown radars do not present a hazard when the antennas are rotating. Although a hazard zone of 138 meters may exist when the antenna is stationary, helicopters may fly within the zone for normal landings and departures.

Electronic equipment can malfunction in the presence of high RF fields. At USAKA such equipment is sited to avoid this occurrence.

Radio frequency currents can be induced in metal objects by intense RF fields. Arcing or sparks can result, although this is extremely rare. During refueling operations, ignition could occur; however, this is considered extremely unlikely and is not specifically controlled.

Inadvertent firing of meteorological rockets during their arming is a similar concern. Currents induced by EMR in the electrical leads connected to the explosive device could result in detonation. This has not occurred at USAKA.

3.15.4 BIRD HAZARDS

Although there have been no recorded sightings of bird injury attributed to EMR, it is theoretically possible. A bird flying along the axis of the beam, either toward or away from the antenna, could receive sufficient RF energy to result in damage. The extent of damage to living tissue as a result of heat would depend on the bird's ability to exit the beam environment in response to heat, its distance from the antenna, and the amount of time it spent in the beam. Absence of reported bird casualties may be a result of the avoidance behavior of birds, the remote chance that a bird would fly along the beam axis, or loss of affected birds at sea.

A more common occurrence would be the transit of a bird across the beam. Assuming a transit angle of 45 degrees across the beam, a bird could be radiated for about 5 seconds (less if the bird crossed at a right angle). For a typical seabird, such as the black noddy at 108-g bodyweight, the absorbed energy from TRADEX (the USAKA radar with the highest power density) would be on the order of 0.2 W/kg in the vicinity of the antenna. This is half the acceptable level for humans (which includes a safety factor of ten times).

Chapter 4
ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

4.1 INTRODUCTION

The Proposed Action and the Change of Duration Alternative have the potential to affect the natural and human environment of Kwajalein Atoll. The following sections identify potential areas, resources, and issues of concern for each major resource group. The criteria by which the significance of impacts have been assessed are specified and the predicted impacts of the Proposed Action and Change of Duration Alternative are described. Where significant impacts of the Proposed Action or Change of Duration Alternative are predicted, mitigation measures are identified. Finally, any irreversible or irretrievable commitments of resources are described.

Significance Criteria

The significance of impacts is measured using guidelines established by the Council on Environmental Quality (CEQ) (40CFR, Parts 1500 to 1508). The CEQ regulations specify that significance should be determined in relationship to both context and intensity. Examining context reflects the fact that significance varies with the setting of the action. For example, impacts may be significant in the immediate surroundings of the action, but insignificant within the context of the island or atoll as a whole.

Intensity refers to the severity of the impact. CEQ regulations state that the following (paraphrased from the regulations) should be considered in evaluating intensity.

- Both positive and negative impacts
- Effects on public health and safety
- Unique characteristics of the geographic area
- The potential for environmental or scientific controversy
- The degree of uncertainty or risk involved
- The establishment of precedent for future actions with significant effects, or decisions in principle about future considerations
- Any relationship to other actions with individually insignificant but cumulatively significant impacts

- Adverse effects on sites or districts listed in or eligible for the National Register of Historic Places or loss or destruction of significant scientific, cultural, or historical resources

- Adverse effects on threatened or endangered species or on their habitat

- The potential for violating federal, state, or local laws or requirements that are in place to protect the environment

With those criteria in mind, three levels of impact were defined for each resource:

1. No or Negligible Impact. No perceptible impact predicted.

2. Insignificant Impact. A perceptible impact predicted, but the impact does not meet the defined standard of significance.

3. Significant Impact. A perceptible impact that meets the standard of significance defined for the specific resource.

4.2 LAND AND REEF AREAS

4.2.1 ISLAND GEOLOGY

Potential Areas of Concern

Resources potentially affected by geologic (i.e., erosion or quarrying) impacts are sites of USAKA facilities, archaeological or cultural features, seabird nesting areas, and native forest areas.

Levels of Significance

The determination of significance is based on a change from the current land configuration (size or elevation of the island or movement of material) and/or composition of minerals or soils, and whether the change has an effect on the listed resources.

- No or Negligible Impact. Little or no change in configuration.

- Insignificant Impact. Change in configuration that does not affect one of the listed resources.

- Significant Impact. Changes in configuration or shoreline erosion that damage or inhibit use of a listed resource.

4.2.1.1 No-Action Alternative

Under the No-Action Alternative, quarrying activities will continue off the ocean shoreline of Kwajalein and Roi-Namur Islands. Because the quarries are sited according to standard practice (i.e., located at least 100 feet from the outer reef edge), increases in shoreline erosion would be minimized or eliminated. As stated in Subsection 3.2.2.3, the setback of 100 feet provides a buffer of reef limestone between the waves and quarry cell and gives adequate protection against natural, very long-term, retreat of the reef.

4.2.1.2 Proposed Action

The Proposed Action includes additional quarry cells to be developed off the ocean shoreline of Meck Island to obtain armor rock or aggregate for the island's lagoon revetment or other construction projects. These quarries will be located at the southeast side of the island (see Figure 2.3-4) and consist of a rectangular (300- by 250-foot) and triangular (150- by 650- by 675-foot) site. Neither the quarrying nor revetment is expected to cause significant impacts to the island or its shoreline as the quarry will be sited at least 100 feet from the outer reef edge. The revetment will provide a positive effect by protecting the island and shoreline from erosion.

4.2.1.3 Change of Duration Alternative

The potential impacts for this alternative are the same as for the Proposed Action described above.

4.2.1.4 Mitigation

Because no significant impacts have been identified, no mitigation is required for either the Proposed Action or the Change of Duration Alternative.

4.2.1.5 Irreversible or Irretrievable Commitment of Resources

Although reef rock is a renewable resource, based on the recolonization rate of the Japanese quarries of the atoll, it is not likely that the proposed quarry at Meck Island would recover rapidly enough to be mined for coral within the next 500 to 1,000 years. The reef rock materials used for armor rock and aggregate will be used for general construction.

4.2.2 MARINE GEOLOGY

Potential Areas of Concern

Potential areas of concern include the coral reefs of Kwajalein Atoll. Because the reef is of biological origin, impacts are discussed in Section 4.6, Marine Biological Resources.

4.3 WATER RESOURCES

4.3.1 FRESHWATER

Potential Areas of Concern

The primary groundwater quality parameter that may be affected by the action alternatives is salinity (chloride concentration) resulting from additional groundwater use. The primary surface water quality parameter that may be affected is turbidity. Increased activities associated with the action alternatives may also affect quality through contamination. Contaminants (organic materials, hydrocarbons, etc.) may be introduced to the groundwater or surface water through increased activities in or adjacent to recharge and catchment areas. This potential is discussed in Subsection 4.12.3, Solid Waste, and Subsection 4.12.4, Hazardous Materials and Waste.

Levels of Significance

The environmental significance of water quality impacts is measured in terms of the effect on human health and safety associated with water use, and in compliance with the provisions of the Safe Drinking Water Act (SDWA). Quantitative criteria set forth by the SDWA limit chloride concentration and other specific contaminants. Variations in chloride concentration, especially those exceeding normal concentrations (15 to 40 mg/L as chloride), indicate overpumping of the groundwater lens and the upconing of subsurface saltwater.

Deterioration of water quality is measured by decline in available quantities of freshwater suitable for consumption. The following levels of significance are defined for use in evaluating the proposed actions:

- No or Negligible Impact. No effect on ground or surface water.

- Insignificant Impact. Water use is less than the available supply of catchment water plus groundwater pumping at a rate less than the allowable

sustained yield for the groundwater lens. Quality meets SDWA requirements.

- Significant Impact. Water use is more than the available supply of catchment water plus groundwater pumping at a rate more than the allowable sustained yield for the groundwater lens, so that chloride levels would reach 100 to 150 mg/L. Water quality would not meet SDWA requirements.

4.3.1.1 No-Action Alternative

Existing freshwater conditions are described in Chapter 3, Subsections 3.3.1 and 3.12.2.1. The surface of the groundwater lens appears to respond relatively quickly to rainwater percolation following frequent intense rainfall episodes. This indicates permeable soil overlying the groundwater lens and the capability to transmit any contaminants that may be introduced to the rainwater.

Under the No-Action Alternative, there will be a shortage of water from the catchment system during drought conditions. Reliance on the groundwater lens to make up the shortage may result in overpumping of the lens, with possible groundwater quality degradation.

4.3.1.2 Proposed Action

The Proposed Action would increase overall potable water requirements throughout the atoll (quantified in Subsection 4.12.1, Water Supply). To the extent that these increases in demand are met by groundwater, the potential for impacting the lens systems exists. The chloride concentration of the water withdrawn should be carefully monitored. Increases in the chloride level are indicative of overpumping and upconing of saltwater from the subsurface.

Kwajalein

The Proposed Action would place increased demands on the groundwater lens, particularly during the dry season or during drought conditions. Temporary overpumping might cause the 250-mg/L isochlor level to rise toward the ground surface as the freshwater stored underground is withdrawn and salt water moves upward. Water with a chloride concentration of less than 150 mg/L could be produced and the short-term degradation should be reversible as long as overpumping does not continue.

During drought conditions, demands could require sustained pumping in excess of the allowable sustained yield. Continued pumping under these circumstances could cause long-term degradation of the groundwater as a result of saltwater intrusion.

The increased chloride concentration that may be caused by overpumping of the lens wells could be mitigated by controlling the withdrawal of groundwater within allowable sustained yield limits for the Kwajalein aquifer. Installation of the proposed 150,000-gpd desalination plant would reduce dependence on groundwater, especially during drought conditions, thereby reducing demand for this resource.

Roi-Namur

The Proposed Action would place demands on the Roi-Namur groundwater lens similar to those discussed above (see also Chapter 3, Subsection 3.12.1). However, as quantified in Subsection 4.12.1, Water Supply, effects on the freshwater system of Roi-Namur are predicted to be less than on Kwajalein and resulting impacts on water quality would be smaller.

4.3.1.3 Change of Duration Alternative

Impacts for the Change of Duration Alternative would be similar to those described for the Proposed Action. However, the groundwater demand would be reduced because of the smaller peak population associated with SDI activities.

4.3.1.4 Mitigation

The impacts of the Proposed Action and Change of Duration Alternative will be mitigated by the installation of the proposed desalination plant on Kwajalein. No significant impacts are predicted for Roi-Namur and no mitigation is called for there.

4.3.1.5 Irreversible or Irretrievable Commitment of Resources

No irreversible or irretrievable commitments of resources are predicted because the freshwater resource is renewable.

4.3.2 MARINE WATER QUALITY

Potential Areas of Concern

Marine water quality parameters that may be affected by the alternatives are temperature, dissolved oxygen, suspended solids, floatables, settleables, enteric bacteria (including coliforms), nutrients (dissolved and organic forms of nitrogen and phosphorus), hydrocarbons, heavy metals, turbidity, and other organic and inorganic pollutants dissolved or suspended in seawater. The concentrations of these materials determine the suitability of the coastal waters to support various resources: marine ecology, fisheries, public health, and aesthetics.

Levels of Significance

The following definitions are used to define significance:

- No or Negligible Impacts. No effect on water quality or effects within the range of natural variability or observed uncertainty; pollutant concentrations not detectable or at minute (trace) levels; no temperature elevations; turbidity increases caused by construction are temporary, localized, and do not exceed 5 nephelometric turbidity units (ntu).

- Insignificant Impact. Measurable effect on water quality but less than the levels allowed by former NPDES permits; less than the levels of pollutants indicated for receiving waters by the U.S. Environmental Protection Agency (EPA) water quality guidelines (1987) or by the receiving water quality standards of the Trust Territory of the Pacific Islands, Environmental Protection Board Rules and Regulations (1978); less than a 3.6°F (2°C) temperature elevation in the receiving waters; or turbidity increases between 5 and 10 ntu.

- Significant Impact. Effects exceeding the levels allowed by NPDES permits; exceeding the applicable levels specified in the EPA receiving water quality guidelines or specified in the Trust Territory water quality standards for receiving waters; temperature elevations equal to or greater than 3.6°F (2°C) that impinge upon the bottom and adversely affect the receiving waters; turbidity increases greater than 10 ntu; and an accumulation of suspended solids on the sea floor within ecologically important areas.

4.3.2.1 No-Action Alternative

Water quality impacts resulting from current operations and facilities are described in Chapter 3, Section 3.3. Under the No-Action Alternative, water quality impacts are expected to remain approximately the same, with the possible exception of increased thermal discharges caused by long-term growth in electrical generation per capita.

4.3.2.2 Proposed Action

Thermal Discharges

Under the Proposed Action, there could be an increase in thermal discharges from the cooling systems of existing Power Plants 1 and 2 on Kwajalein Island, the Roi-Namur

power plant, and Power Plant 1A on Kwajalein (now in construction). A 3.6°F (2°C) increase above ambient temperature is generally considered the minimum constant increase needed to cause lethal or sublethal effects on reef corals (Jokiel and Coles, in press). Lethal or sublethal effects on reef corals serve as an excellent indicator of the status of bottom marine life in the tropical Pacific Ocean. The effluent temperature from USAKA power plant cooling systems is predicted to be a maximum of 10°F (5.6°C) above ambient water temperature.

The potential for significant thermal effluent impacts off Kwajalein and Roi-Namur Islands was investigated by modeling the extent of the buoyant thermal plume from power plant cooling systems using the EPA's PDS Dilution Model for Thermal Discharges into Shallow Water. Based on available thermal outfall design information and assuming full capacity output, the thermal effluents of Power Plants 1, 1A, and 2 and the Roi-Namur power plant cooling systems are predicted to create buoyant thermal plumes that will not exceed a distance of 6 m downstream from the outfall and will cover an area less than 10 m^2 bounded by the 3.6°F (2°C) isotherm (i.e., the mixing zone in which the effluent would cool from 10°F [5.6°C] above ambient water temperature to 3.6°F [2°C] above ambient temperature). The thermal plume mixing zone is not predicted to impinge on the ocean bottom, and therefore, no significant impacts of thermal effluents on bottom marine life are predicted.

Sewage

The increased sewage discharges resulting from the increased population under the Proposed Action could lead to periodic exceedances of suspended solids and BOD standards. In the past, population levels were higher on Kwajalein Island than expected under the Proposed Action, and recent biological observations in the vicinity of the outfall (Titgen, et al., 1988) did not reveal any residual ecological effects of previous sewage discharges nor any current effects of present discharges. Thus, it is predicted that increased sewage discharges off Kwajalein Island would not result in significant adverse water quality effects.

Sewage discharges off Roi-Namur are not expected to be significant under the Proposed Action if current plans to install a package sewage treatment plant are implemented. The plant and outfall would be designed to achieve compliance with applicable permits and to avoid adverse ecological or other water quality effects.

Dredging and Quarrying

Under the Proposed Action, a quarry may be opened off Meck Island to support construction on that island, and a break-

water would be constructed at the Meck harbor. None of the quarrying activities at Meck is expected to result in significant water quality effects. The generation of turbidity and suspended sediments is expected to be minor and temporary.

Modification of harbor and jetty structures off Omelek Island may require dredging or related bottom disturbance under the Proposed Action. This may cause significant adverse water quality effects because unconstrained construction activities in the water may generate suspended sediments and turbidity that would settle onto sensitive coral reef habitats (Titgen, et al., 1988).

Solid Waste

The Proposed Action would increase the volume of scrap metal refuse, garbage, waste oil, and other municipal solid waste disposed of on Kwajalein and Roi-Namur Islands. Based on existing evidence of marine water contamination by heavy metals, bacteria, and nutrient levels from among these sources off Kwajalein Island, increased levels of these solid wastes are expected to increase the levels of water quality contamination off both Kwajalein and Roi-Namur. The heavy metal levels would continue to exceed the EPA water quality guidelines for copper and lead, and to exceed Trust Territory receiving water standards for copper and zinc.

Based on samples of marine organisms taken off the Kwajalein Island solid waste complex (USAEHA, 1977), crabs, clams, and other marine life have bioaccumulated copper and other heavy metals that are known to be toxic to marine life. Off the Kwajalein Island dump, the additional effects of nutrient and bacterial loadings have degraded water quality. Elevated bacterial and hydrocarbon levels stress fish, bottom plants, and bottom animals. Because increased quantities of solid waste will be disposed of under the Proposed Action, adverse water quality impacts are predicted to be significant off the Kwajalein solid waste complex and may be significant off the Roi-Namur site.

4.3.2.3 Change of Duration Alternative

Water quality impacts resulting from the Change of Duration Alternative are expected to be comparable to those of the Proposed Action with the following possible exceptions. Sewage discharges off Kwajalein Island would have better quality, but would occur over a longer time period compared with discharges resulting from the Proposed Action. There would be less likelihood or frequency of suspended solids and BOD exceeding allowable secondary treatment levels as specified in the former NPDES permit.

4.3.2.4 Mitigation

Mitigation for sewage, solid waste, hazardous waste, dredging, and quarrying are described in their respective sections of this chapter. Mitigations for the impacts of the action alternatives on marine water quality are described below.

Dredging

In the vicinity of ecologically important areas such as the Omelek harbor area, dredging operations should incorporate control measures. These measures include the use of silt curtains to prevent the movement of turbidity and suspended sediments over valuable coral reef areas and/or the use of a turbidity control standard. The standard could be established to allow dredging operations to continue provided that turbidity levels are not elevated 10 ntu above background levels within an established zone of mixing (defined in Corps of Engineers standard contracts specifications as a distance of 500 feet from the point of dredging). Silt curtains deployed around the dredge site could serve to reduce the zone of mixing distance and allow dredging to occur adjacent to valuable ecological areas.

Solid Waste

Monitoring for heavy metals, hydrocarbons, bacteria, nutrients, tissue concentrations of metals, sediment concentrations of heavy metals, bioassay tests and, possibly, bioaccumulation tests for crabs and other organisms (suspected of taking up contaminants) are recommended to mitigate for waste disposal practices. This monitoring would establish whether improvements in waste handling procedures result in improvements to adjacent water quality.

4.3.2.5 Irreversible or Irretrievable Commitment of Resources

No irreversible or irretrievable commitments of resources are predicted because no significant unmitigatable impacts are anticipated.

4.4 AIR QUALITY AND NOISE

4.4.1 AIR QUALITY

Potential Areas of Concern

Activities associated with the alternatives that have the potential to impact air quality in the atoll include power generation, solid waste incineration, transportation, fuel storage and handling, and rocket launches. Impacts from

these activities can affect air quality at ground level as well as in the upper atmosphere.

Levels of Significance

Levels of significance are defined as:

- No or Negligible Impact. There would be no change in air pollutant emissions relative to existing conditions.

- Insignificant Impact. Air pollutant emissions would increase, but the increase would be less than the EPA thresholds defining major increases in emissions [40CFR51.166(6)(23)(i)]:

CO	100	tons/year
VOC	40	tons/year
NO_x	40	tons/year
SO_2	40	tons/year
PM10	15	tons/year

  Increases in air pollutant emissions would not cause or contribute to exceedances of ambient air quality standards.

- Significant Impact. The increase in air pollutant emissions would cause or contribute to a violation of an ambient air quality standard (Table 3.4-1), or would cause or contribute to exceedance of the applicable toxic air contaminant health criterion (Subsection 3.4.1.1).

4.4.1.1 No-Action Alternative

Kwajalein Island

Air pollutant emissions on Kwajalein from the power plants, solid waste incineration, motor vehicles, aircraft, and fuel storage will remain approximately at existing levels. A description of existing air quality is provided in Chapter 3, Subsection 3.4.1.

Construction of Power Plant 1A is considered part of the No-Action Alternative and is scheduled to be completed in 1989. Impacts from increased dust and vehicle activity associated with construction will be local, periodic, and insignificant.

Roi-Namur Island

Power plant emissions are estimated to increase by about 9 percent above existing rates. Relating the emission rates and source characteristics of the Roi-Namur power plant to

Power Plant 1 emission rates, source characteristics and modeled impact results, exceedances of ambient air quality standards are not expected to occur. Additional air quality evaluations should be performed if annual fuel consumption above the projected 1998 rate of 3,220,000 gallons/year is anticipated.

Other Islands

Power generation on the other USAKA islands is estimated to increase about 10 percent over existing conditions. The power generation increase will produce a corresponding 10 percent increase, but not a major increase in emissions from sources on the other islands. These increases in emissions are predicted to result in insignificant air quality impacts.

Rocket Launches

Rocket launches for the HAVE-JEEP program are scheduled for the 1988 through 1990 period. Five missions are planned to be launched from Roi-Namur. The largest of the three boosters to be used in HAVE-JEEP will produce about 5,900 pounds of combustion emissions. Analysis of a launch with a larger booster indicates that the air quality impacts from the HAVE-JEEP launches will be insignificant. Details of the analysis are presented in the proposed alternative discussion.

4.4.1.2 Proposed Action

Kwajalein Island

Air pollutant emissions in the Proposed Action will increase over existing emission rates. Existing sources as well as new sources will have emissions increases. A summary of projected emission rates for the peak year of operations (approximately 1994) is presented in Table 4.4-1. Operation of Power Plant 1A, considered to be part of the Proposed Action, will be a major new source of air pollutants on Kwajalein. Annual emissions from Power Plant 1 will decrease compared to existing emissions. Power Plant 1 will supplement power generated by Power Plant 1A instead of serving as the main power supply on the island. Power generation and emissions from Power Plant 2 and emissions from the other sources on Kwajalein will increase relative to existing and no-action conditions.

Dispersion modeling was performed to estimate the air quality impact of projected emissions increases. All of the sources on Kwajalein Island were input into the model and

Table 4.4-1
PROPOSED ACTION
PROJECTED AIR POLLUTANT EMISSION ESTIMATES[a]
(tons/year)

Island	Source	PM10	NO_x	CO	SO_2	VOC
Kwajalein	Power Plant 1 (13.5 mW)	33	333	87	40	9
	Power Plant 1A (10 mW)	34	1,390	116	98	41
	Power Plant 2 (5.3 mW)	22	224	58	27	6
	Fuel Tank Farm	--[b]	--[b]	--[b]	--	42[b]
	Trar.sportation--motor vehicles	1[b]	9[b]	124[b]	1[b]	15[b]
	Transportation--aircraft	6[b]	16[b]	51[b]	2[b]	43[b]
	Solid waste incineration[c]	49[b]	19[b]	260[b]	11[b]	91[b]
Roi-Namur	Power Plant (12 mW)	80	799	208	96	22
	Oil waste disposal[d]	Yes	Yes	Yes	Yes	Yes
Meck	Power Plant (2.8 mW)	16	160	42	18	4
Ennylabegan	Power Plant (0.8 mW)	6	50	13	6	1
Other Islands	Power Plant (total)	8	108	24	7	9

[a]Estimates are based on EPA emission factors (EPA, 1985), projected fuel use data for power plants and tank farm, and projected peak annual aircraft and motor vehicle operations.
[b]Source: Morrow, 1989.
[c]Includes oil waste disposal.
[d]Emissions data not available.

maximum concentrations predicted. The predicted maximum impacts are listed in Table 4.4-2.

Table 4.4-2
PROPOSED ACTION
PREDICTED AIR QUALITY CONCENTRATIONS, KWAJALEIN ISLAND

Pollutant	Period	Second Highest Concentrations ($\mu g/m^3$)	EPA Ambient Air Quality Standard ($\mu g/m$)
PM10	24-hour	1,739.0[a]	150
	Annual	180.0[a]	50
NO_2	Annual	200.0[a]	100
CO	1-hour	212,000[a]	40,000
	8-hour	27,500[a]	10,000
SO_2	3-hour	820.0	1,300
	24-hour	111.0	365
	Annual	30.8	80

[a]Value exceeds ambient air quality standards.

Source: Morrow, 1989.

NO_x. Exceedances of the NO_2 standard were predicted to occur in existing (no-action) conditions. Results of the modeling analysis indicate that after the Proposed Action is implemented, continued exceedances of the NO_2 standard are possible downwind of Power Plants 1 and 1A and downwind of the solid waste burning pit (Morrow, 1989). The modeling was based on the conservative assumption that Power Plant 1 would continue to operate at existing levels when in fact it is projected to operate at 30 percent of existing conditions. Even using the reduced operation of Power Plant 1 assumption, exceedances of the NO_2 standard at the maximum impact point are predicted. Project-related emission increases from Power Plant 1A, Power Plant 2, and the solid waste burning pit will contribute to the exceedance and will have a significant air quality impact.

Air quality levels in the permanent housing areas are not expected to exceed standards. However, some temporary (construction worker) housing is located in the high impact areas downwind of the large air pollution sources.

PM and CO. As is the case for existing (no-action) conditions, exceedances of the PM and CO standards are projected to occur under the Proposed Action. The primary cause is the solid waste burning pit, but the power plants also contribute (Morrow, 1989). Impacts from the emission increases associated with these sources are significant because they will contribute to a potential exceedance of standards.

SO_2. Exceedances of the SO_2 standard are not predicted assuming the fuel sulfur content will remain at the existing 0.2 to 0.3 percent (Morrow, 1989).

Roi-Namur Island

Fuel consumption in the power plant under the Proposed Action is estimated to remain the same as in the No-Action Alternative (Table 4.12-1). There should be no additional air quality impact if fuel consumption does not change.

Meck Island

Operation of the power plant on Meck will produce air pollutant emission increases. Emissions from the power plant will be less than the estimated emission from Power Plant 2 on Kwajalein (Table 4.4-1). Modeling results for Power Plant 2 on Kwajalein show that exceedances of the air quality standards are not expected to occur as a result of this source alone (Morrow, 1989). Assuming the modeling results for Power Plant 2 apply to the Meck power plant (a smaller facility), significant air quality impacts from the Meck power plant should not be anticipated.

Other Islands

Air quality impacts from power plant emissions will be insignificant because emissions increases are less than the EPA-defined emission thresholds for all pollutants [40CFR51.166(b)(23)(i)].

Rocket Launches

Construction. Construction activities for SDI programs are scheduled to take place from 1988 through 1992. The majority of new construction will occur on Meck Island. Construction may produce localized increases in dust and vehicle emissions. These increases will be periodic and are not expected to have significant air quality impacts.

Assembly. Missiles will be shipped to USAKA and then prepared, cleaned, painted, and assembled for launch. HEDI, SBI, and ERIS missiles will be assembled in missile assembly buildings on Meck; the Omelek missile assembly building will be used for GSTS. Solvents, degreasers, and paints will be used and will emit VOCs from the missile assembly buildings.

Quantities of materials to be used in missile assembly are not known; therefore, VOC emission estimates cannot be made. Through 1996, approximately 17 missile launches are planned. A peak year may have 4 launches. Annual VOC emissions for preparation and assembly of 4 missiles of 120 pounds/year, based on about 30 pounds of VOC per vehicle (U.S. DAF, 1988) are not expected to produce an exceedance of the ozone standard or significant air quality impacts.

Liquid Propellants. Liquid propellants such as monomethyl hydrazine (MMH) and nitrogen tetroxide will be used on some of the missile launches on Meck (i.e., HEDI and ERIS). These propellants are toxic if inhaled. Storage facilities for the liquid propellants are monitored to detect and prevent releases to the atmosphere. Spills during handling could also cause a release to the environment. The liquid propellants are stored and handled in small containers. Liquid propellants are not handled in bulk. Liquid propellants are transferred to the missiles with the containers intact, thereby reducing the potential for spills. Each missile will contain only relatively small quantities (HEDI will use only approximately 55 pounds of MMH and 66 pounds of nitrogen tetroxide), again reducing the potential for a major spill and release. If a spill occurred, worker exposure to elevated levels could be quite high. However, the small quantity spilled should be dispersed rapidly in the atmosphere and, with appropriate cleanup, would not be expected to produce long-term significant offsite air quality impacts.

Launches. There are several types of solid rocket motors planned to be fired during the SDI program at Kwajalein. Emission estimates for each of the solid rocket motors is provided in Table 4.4-3. A review of these planned activities revealed that the simultaneous launching of two Polaris A3 or Poseidon C3 or equivalent solid rocket booster systems from the island of Omelek in support of GSTS produces the largest quantity of Al_2O_3 rocket exhaust products per event. The first-stage booster for SBI will have the largest HCl emission.

The modeling of the atmospheric dispersion of the rocket exhaust products from GSTS launches at Omelek Island and SBI launches at Meck Island was accomplished using the Rocket Exhaust Effluent Dispersion Model (REEDM) developed by NASA and currently being used by NASA and the U.S. Air Force in support of environmental activities at the Eastern and Western Test Ranges. This model requires upper air data from atmospheric sounding and rocket motor exhaust properties as input and produces estimates of concentrations and dosages of the exhaust products at downwind distances from 200 meters to 30 kilometers. Upper air data were obtained from the 1988 soundings taken at Kwajalein Atoll.

Table 4.4-3
APPROXIMATE MISSILE LAUNCH COMBUSTION PRODUCTS
NO-ACTION AND ACTION ALTERNATIVES

	No Action Alternative			Action Alternatives									
Solid Rocket Booster Type	Talos	Sergeant	Hydac	ARIES First Stage	ARIES Second Stage	ARIES Third Stage	First Stage	Second Stage	Polaris A3[a] First Stage	Polaris A3[a] Second Stage	Castor IV	Antares III	Star 27
Mission	HAVE-JEEP	HAVE-JEEP	HAVE-JEEP	SBI	ERIS, SBI	*ERIS*	*HEDI*	*HEDI*	GSTS	GSTS	SBI	SBI	SBI
Location	Roi-Namur	Roi-Namur	Roi-Namur	Meck Island	Meck Island	Meck Island	Meck Island	Meck Island	Omelek	Omelek	Roi-Namur	Roi-Namur	Roi-Namur
Combustion Products (lbs)													
Hydrogen chloride	--	12.30	86.00	10,040.00	2,169.00	122.00	1,040	263	3,475.64	136.80	4,430.20	633.00	167.00
Aluminum oxide	--	--	124.00	13,065.00	3,216.00	1,302.00	1,281	323	7,845.67	3,068.60	5,402.40	913.00	211.00
Water	96.00	1,121.00	23.00	4,460	999.00	185.00	1,859	469	1,318.70	555.60	1,732.00	299.00	85.00
Carbon dioxide	308.00	1,545.00	10.00	1,678.00	325.00	122.00	2,485	627	465.91	378.00	839.50	101.00	32.00
Carbon monoxide	353.00	917.00	118.00	11,263.00	2,690.00	1,348.00	1,546	390	5,193.70	2,969.00	5,733.30	576.00	161.00
Nitrogen	113.00	478.00	34.00	4,105.00	882.00	517.00	1,154	291	1,971.82	1,635.00	1,779.00	250.00	65.00
Hydrogen	15.00	64.00	11.00	964.00	253.00	64.00	40	10	484.63	129.80	498.40	55.00	14.00
Chlorine	--	--	0.07	95.00	23.00	5.00	--	--	43.68	8.90	6.10	9.00	--
Hydrogen sulfide	--	600.00	--	--	--	--	--	--	--	--	--	--	--
Other	--	--	--	--	9.00	--	8	2	--	--	--	--	--
Total	2,792.00	5,928.00	406.00	45,670.00	10,566.00	3,665.00	9,414	2,377	20,799.70	8,881.70	20,421.00	2,836.00	735.00
Liquid Propellants (lbs)													
Freon 114B2									200				
MMH	N/A	N/A	N/A		10		55						
Nitrogen tetroxide	N/A	N/A	N/A		10		66						
Helium									21				
Nitrogen									1				

[a]GSTS may use modified Poseidon C3 Trident C4 booster systems.

Source: SDIO.

PD435.025.1

The REEDM computer program was run using the hazard estimation mode in which the height of the mixing layer is not allowed to fall below the center of the stabilized exhaust cloud, thereby ensuring that the ground level concentration of exhaust products is maximized. Two scenarios were used with the REEDM computer code: a normal launch condition and a conflagration condition in which all fuel from the boosters burns within 2 minutes on the launch pad after an accident has caused the breaking of the motor casing. A typical sounding and a modified sounding were used in initial executions of the REEDM computer model. The modified sounding was developed to estimate a worst-case scenario by inserting a temperature inversion at a height of 2,000 feet, limiting the plume rise and lowering the mixing layer height, which resulted in enhanced ground level concentrations. The results of these calculations are shown in Table 4.4-4.

Table 4.4-4
PREDICTED ROCKET LAUNCH IMPACTS

Scenario	Pollutant	Maximum Peak Concentration (μg/m³)	30-Minute Mean Concentration (μg/m³)	Distance (km)
Normal Launch				
Typical Sounding	HCl[a]	78	1.5	18
	Al_2O_3[b]	880 ppm	--	16
Modified Sounding	HCl[a]	241	4.5	9
	Al_2O_3[b]	2,913 ppm	--	10
Conflagration Launch[c]				
Typical Sounding	HCl[a]	2,742	45.5	20
	Al_2O_3[b]	2,926 ppm	--	22
Modified Sounding	HCl[a]	7,090	130.3	13
	Al_2O_3[b]	7,004 ppm	--	13

[a]SBI ARIES First Stage.
[b]GSTS Polaris A3 First Stage (dual launch).
[c]All fuel burns on launch pad after accident.

The predicted rocket launch impacts are calculated to be well below ambient guideline concentrations (Subsection 3.4.1.1) for the highest launch emission scenario (i.e., dual launches of GSTS for Al_2O_3 and SBI for HCl). Impacts from other launches should be less than the predicted concentrations shown in Table 4.4-4. Ground level air quality impacts from rocket launches are estimated to be insignificant.

Carbon monoxide is emitted in significant quantities during rocket launches. Because the exhaust is so hot, CO continues to oxidize to CO_2 after being emitted. Predicted CO impacts from similar or larger rockets are less than 3 ppm for instantaneous peak centerline impacts (U.S. DOT, 1986). The 1-hour CO standard is 35 ppm. Impacts from CO are expected to be insignificant.

It is possible that rain or mist precipitated through the launch exhaust clouds could absorb HCl and produce acidic rain. Acidic rain could produce effects on vegetation, soils, and water quality. The variation in meteorological conditions and number of launches make the possibility of long-term effects unlikely. Control of acidic rain in the general region of the launch site can be achieved by the consideration of meteorological conditions (i.e., rain) at the time of the launch (U.S. DOT, 1986).

Upper Atmospheric Effects. Because of the anticipated worldwide increase in space vehicle activity, studies have been conducted to estimate the effects of carbon dioxide (CO_2), water, HCl, and NO from rocket launch exhaust in the earth's upper atmosphere. Major effects identified in the studies include compositional changes in the atmospheric layers (e.g., impacts to the ozone layer) and climatic effects (Garrett, 1980).

One simulation evaluated the effect of 700 launches per year on the ozone layer. The primary pollutants that may impact the ozone layer are water vapor, CO_2, and NO. About 22 percent of the mass of a reentry vehicle (RV) converts to NO in the upper atmosphere (Garrett, 1980). Water vapor and CO_2 are emitted during propellant combustion. Given the limited database of information, a conclusion drawn from the simulation was that the effect on total, vertical ozone concentration is negligible (Garrett, 1980). In an evaluation of upper atmospheric impacts of a Titan III E launch vehicle, the effect of the exhaust emission on ozone concentration was considered to be negligible because of the small area covered by the exhaust cloud (U.S. DOT, 1986). The Titan III E vehicle has about an order of magnitude greater emission than the largest vehicle in the Proposed Action. Therefore, the impacts of rocket launches on the ozone layer under the Proposed Action are estimated to be insignificant.

Emissions of HCl in the upper atmosphere above 90 km may have an effect on ionization levels (i.e., radiowave transmission). The quantity of HCl emissions from rockets that reach that altitude should not be significant (U.S. DOT, 1986).

No conclusive indications exist that rocket exhaust emissions will cause climate effects. Preliminary study of the issue indicates that small-scale atmospheric effects are possible from cumulative rocket impacts, but that it is unlikely that such effects will have a significant global influence (Garrett, 1980). For the Titan III E vehicle, the emissions of H_2O and CO_2 were found to have negligible effects on the global radiation balance because of the small area needed to diffuse concentrations to background levels (U.S. DOT, 1986). Launches of much smaller vehicles from USAKA should also have negligible effects on climate.

4.4.1.3 Change of Duration Alternative

Annual air pollutant emissions in the Change of Duration Alternative for motor vehicles, aircraft, and solid waste incineration will be slightly less than in the Proposed Action primarily because the activities are distributed over a longer time frame. Power plant and tank farm emissions will be the same for both alternatives (Table 4.4-1). Air quality impacts for the Change of Duration Alternative are the same (slightly less in magnitude) as described in the Proposed Action. Exceedances of the NO_2, CO, and PM standards are predicted to occur on Kwajalein. Activities in the Change of Duration Alternative will contribute to the exceedances and will have significant air quality impacts.

Rocket launch impacts are the same as those described for the Proposed Action because the same missions are included in both alternatives. Insignificant air quality impacts are estimated.

4.4.1.4 Mitigation

Air quality mitigation measures are the same for both the Proposed Action and Change of Duration Alternative. The only significant air quality impacts identified occur on Kwajalein.

Implementation of mitigation measures on Power Plant 1, Power Plant 1A, and the solid waste burning pit should reduce ambient air quality concentrations even with the Proposed Action to less than the ambient air quality standards for NO_2, PM, and CO.

Monitoring and source testing to verify emissions and ambient air quality concentrations should be performed. If

exceedances of ambient air quality standards are verified, the following mitigation measures should be implemented.

For Power Plant 1:

- Alter operation of Power Plant 1 to reduce emissions to acceptable levels by such measures as reducing the operating hours and number of units operating.
- A taller stack would reduce ground level impacts. The height and effectiveness in reducing air quality impacts would have to be determined based on dispersion modeling.
- Replace engines with units that have more effective NO_x controls.

For Power Plant 1A:

- Review Power Plant 1A design under New Source Review criteria for compliance with best available control technology (BACT).

For the solid waste burning pit:

- Cease solid waste burning operations.
- Install an incinerator with appropriate air pollution controls to more efficiently combust the waste.

4.4.2 NOISE

Potential Areas of Concern

The environmental significance of noise impacts is evaluated against criteria established by government agencies or technical organizations. Background information on noise and the various types of noise descriptors used in this section is included in Chapter 3, Subsection 3.4.2.

The Department of the Army has specific noise limits outlined in Chapter 7 of AR 200-1, "Environmental Quality-Environmental Protection and Enhancement." Chapter 7, which is titled "Environmental Noise Abatement Program," addresses noise and describes DNL noise levels defined by three ranges of acceptability, as shown in Table 4.4-5. The regulation applies to U.S. Army installations and activities, both in the United States and overseas. Three types of noise descriptors are used in the analysis of impacts. DNL noise levels are a 24-hour description used to evaluate noise that is relatively constant over much of the day, such as power plant noise. DNL noise is divided into three zones and

apply to noise-sensitive areas, excluding the workplace. Zone 1 limits noise to levels that will annoy less than 15 percent of the population. Zones II and III limit noise annoyances to more than 15 percent but less than 40 percent, and 40 percent or more, respectively.

Table 4.4-5
NOISE LEVEL CLASSIFICATION

Zone/Acceptability	Noise Level (DNL)
Zone 1--Acceptable	<65
Zone 2--Normally unacceptable	65 to 75
Zone 3--Unacceptable	>75

For noise levels of short duration, dBA measurement units are used. These levels apply to activities such as rocket launches. Excessive short-term noise events can be weight-averaged using DNL. Noise from construction activities is limited by criteria measured in dBA. A typical construction noise regulation allows noise levels equal to hourly levels of 85, 90, and 95 dBA for resident, commercial, and industrial areas, respectively. Workplace noise is regulated by the Occupational Safety and Health Act (OSHA). The actual limit varies depending on the total time of daily exposure. The limit for an 8-hour exposure is a time-weighted average of 90 dBA. The limit for 15 minutes or less is 115 dBA.

Levels of Significance

- No or Negligible Impact. No increase in constant noise, as measured by DNL noise levels. Short-term maximum noise levels not greater than 82 dBA in noise-sensitive areas.

- Insignificant Impact. No increase in noise that exceeds the 65-DNL 24-hour standard or exceeds 92 dBA maximum short-term noise level in noise-sensitive areas, or that exceeds OSHA limits in the workplace.

- Significant Impact. Increases in noise that exceed the 65-DNL 24-hour standard or the 92 dBA maximum short-term noise levels in noise-sensitive areas, or that exceed OSHA limits in the workplace.

4.4.2.1 No-Action Alternative

Existing noise conditions are described in Chapter 3. The No-Action Alternative activity that will generate

substantial noise will be the construction of Power Plant 1A. Construction activities typically generate noise levels in the range of 77 to 89 dBA at 50 feet. The noise level at the closest noise-sensitive area should be no greater than 53 dBA, which is not significant.

4.4.2.2 Proposed Action

Kwajalein. Several of the programs would require construction. These activities would be short term and no significants impacts are expected.

The annual volume of aircraft would increase by as much as 15 percent during the scheduled program activities. This would result in a DNL increase of about 1 dBA, which is negligible.

Missile launches would occur at other islands and would have no significant impact at Kwajalein Island.

Operation of Power Plant 1A would result in a DNL level of about 66 dBA at the nearest noise-sensitive property. This slightly exceeds the significance level of 65 dBA. However, the noise level will be totally dominated by existing Power Plant 1. Equipping both power plants with residential-type exhaust silencers would reduce their cumulative noise level in noise-sensitive areas below 65 dBA DNL.

Roi-Namur. Construction activities would be short term. No significant impacts are expected.

Aircraft volume would increase with a resultant DNL increase of about 1 dBA, which is negligible.

The HAVE-JEEP missile launches would continue and the SBI target missile launches would be initiated from the island. Personnel on the island during launches would not be significantly affected because the range safety procedures provide for their hearing protection. The levels at Ennubirr, the closest inhabited island, would not exceed the levels of significance. The levels from SBI launches are illustrated in Figure 4.4-1.

Meck, Omelek, and Other Islands. Construction activities would be short term. No significant impacts are expected.

Missile launches would occur from Meck and Omelek. Range safety procedures would prevent significant impacts to the workers on the islands during launches. The levels at Ninji, the closest other inhabited island, would not exceed the levels of significance. The levels from GSTS and HEDI launches are illustrated in Figures 4.4-2 and 4.4-3.

Operation of very small power plants on other islands should have no significant impact.

4.4.2.3 Change of Duration Alternative

Atoll-Wide Impacts. This alternative delays the implementation of the HEDI program by 4 years. This would result in a 4-year delay before noise is generated by these activities. However, the resultant noise levels should not be significant regardless of when they occur.

4.4.2.4 Mitigation

Mitigation would be the same for both the Proposed Action and the Change of Duration Alternative. Kwajalein Power Plants 1 and 1A should both be monitored for noise output. If noise from the plants exceeds established criteria, they should be equipped with exhaust silencers.

4.4.2.5 Irreversible or Irretrievable Commitment of Resources

None of the alternatives will result in an irreversible or irretrievable commitment of resources related to noise.

4.5 ISLAND PLANTS AND ANIMALS

4.5.1 ISLAND FLORA

Potential Areas of Concern

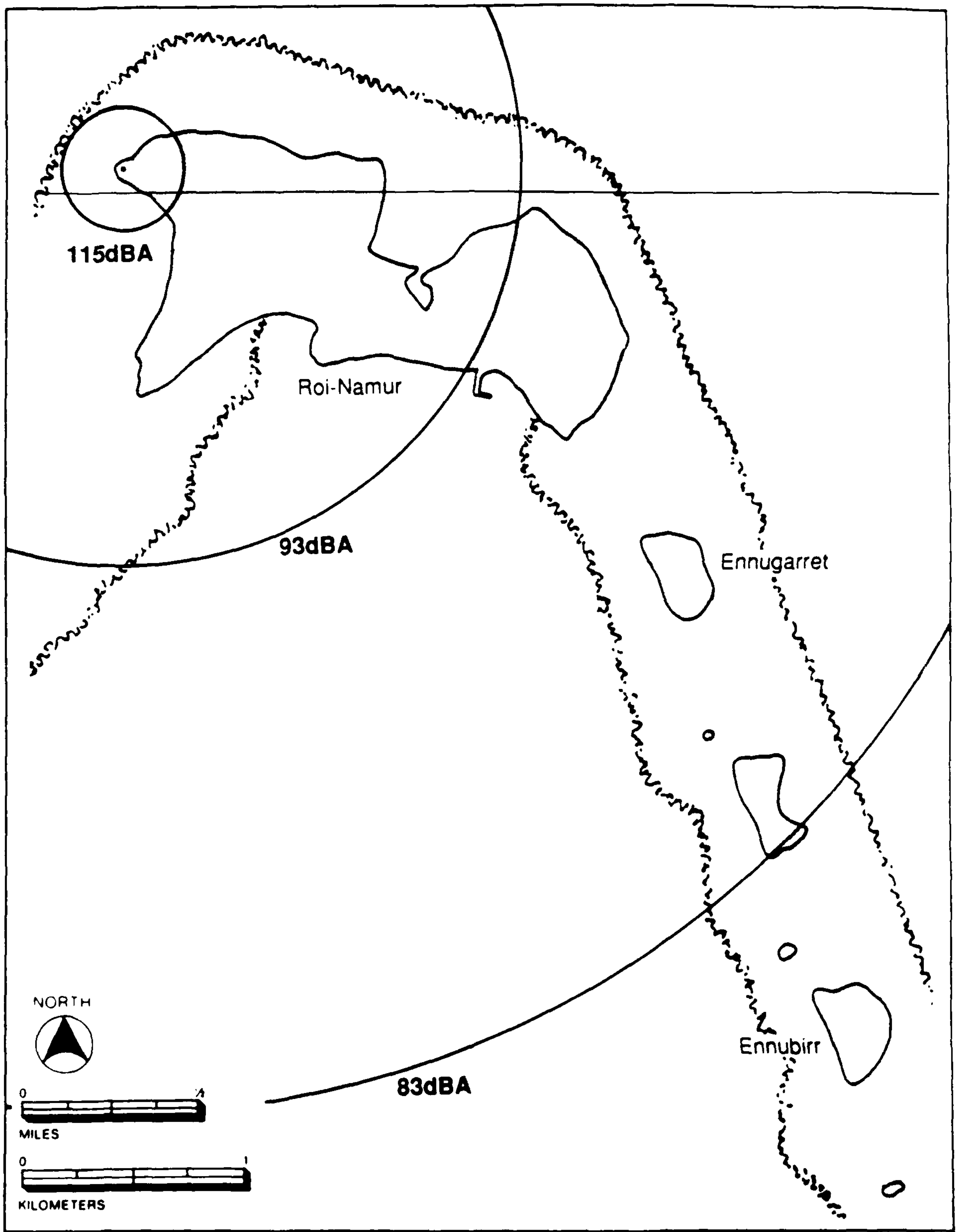
The Proposed Action and Change of Duration Alternative include the construction of new land-based facilities and the renovation or expansion of some existing facilities on several USAKA islands. The potential for significant impacts to terrestrial vegetation is limited to Omelek.

Levels of Significance

Impacts are considered significant if they destroy native trees or disturb the soil in a way that prevents normal tree growth.

- No or Negligible Impact. Impacts are considered negligible if no flora are destroyed or disturbed.

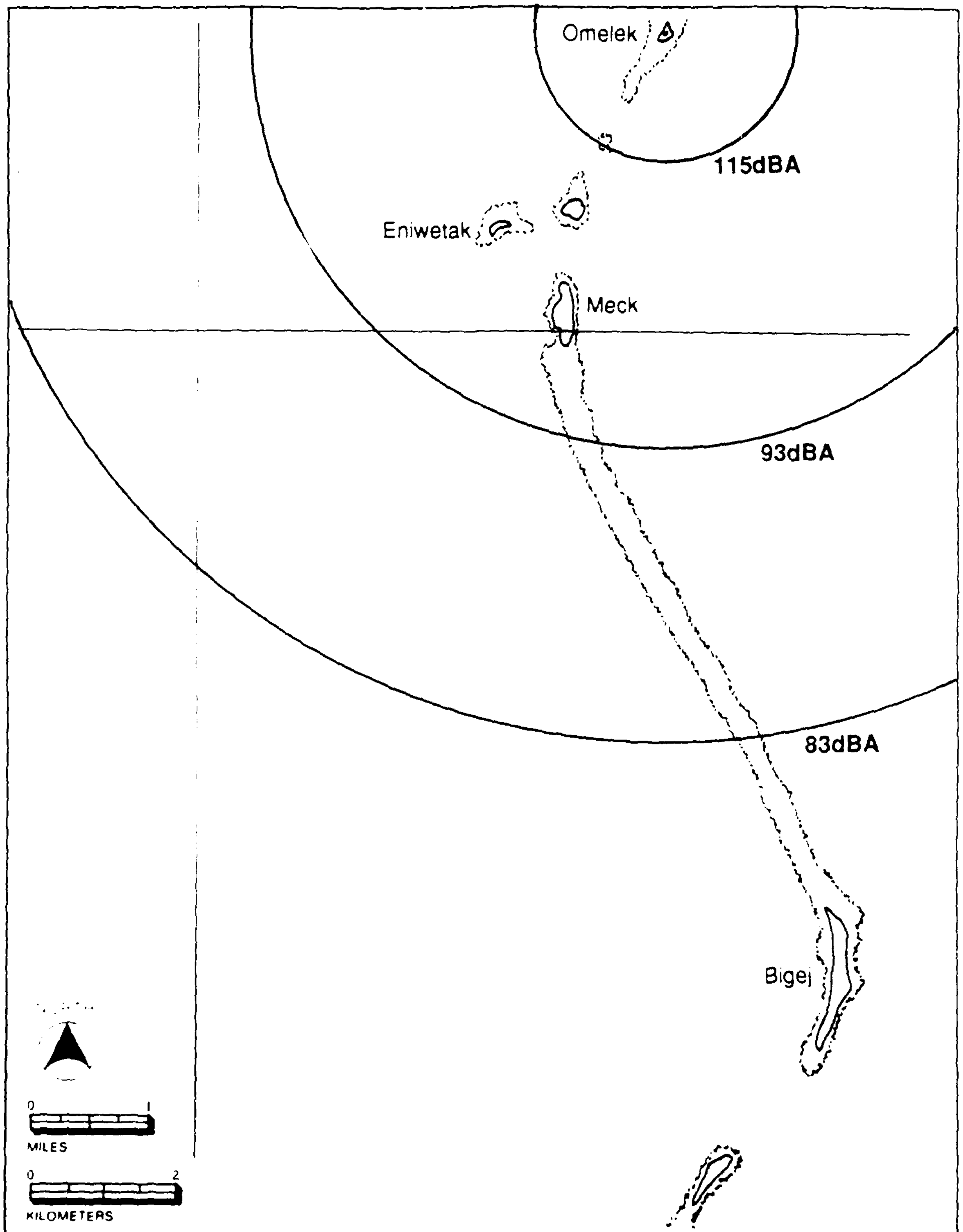
- Insignificant Impact. Impacts are considered insignificant if the proposed activity will result in the disturbance of flora, but will not adversely affect sensitive habitats or rare plants. Natural erosion protection is not degraded.



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U S Army Corps of Engineers

SBI ROCKET LAUNCH NOISE CONTOURS MAXIMUM LEVELS

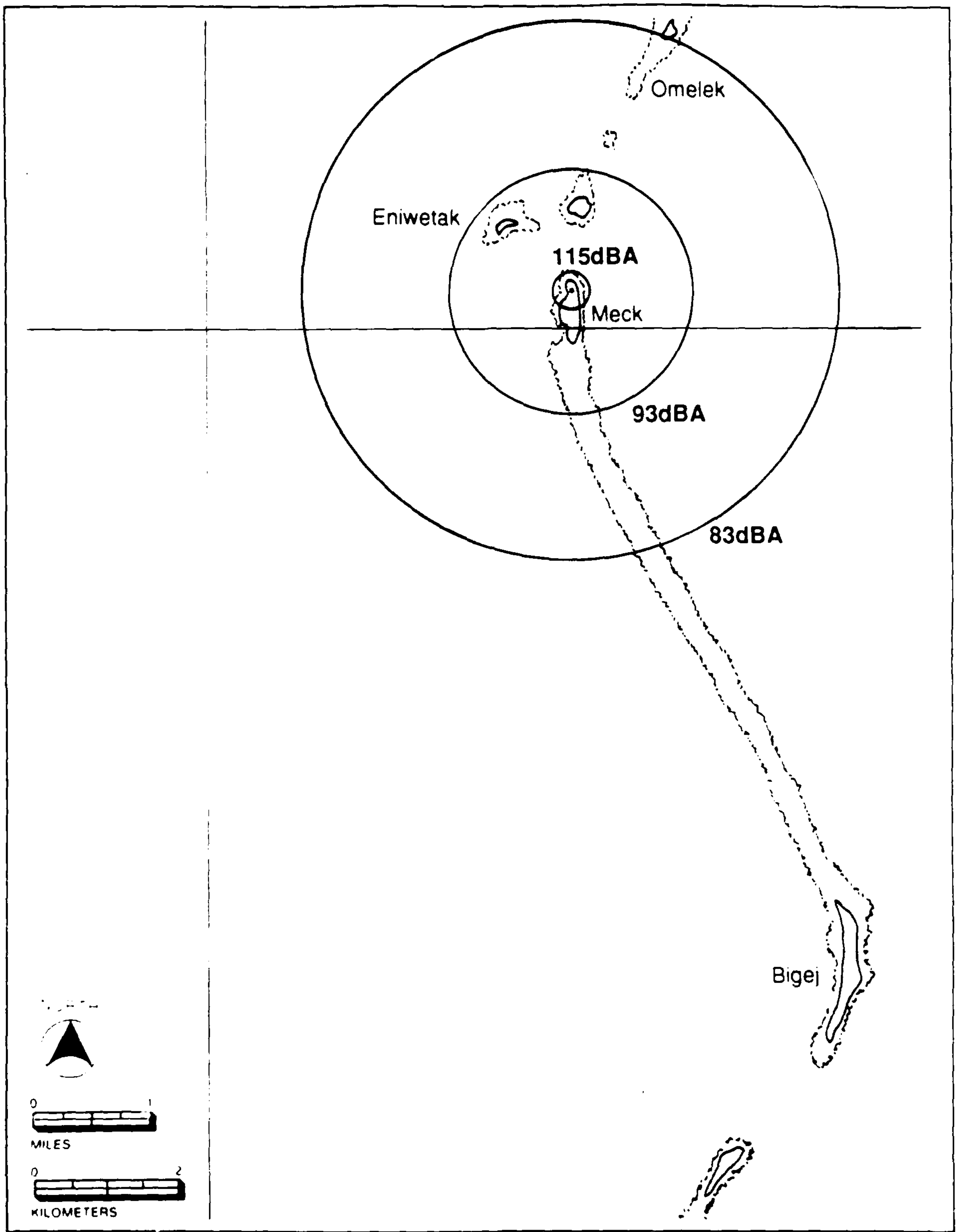
Figure 4.4-1



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

GSTS ROCKET LAUNCH NOISE CONTOURS MAXIMUM LEVELS

Figure 4.4-2



U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U S Army Corps of Engineers

HEDI ROCKET LAUNCH NOISE CONTOURS MAXIMUM LEVELS

Figure 4 4-3

- Significant Impact. Impacts are considered significant if the proposed activity will permanently disturb or destroy sensitive habitats or rare flora. Natural erosion protection is degraded.

4.5.1.1 No-Action Alternative

Existing conditions for island flora are described in Chapter 3, Subsection 3.5.1.

4.5.1.2 Proposed Action

The Proposed Action includes construction of missile facilities on Omelek Island. The exact site for the GSTS facilities on Omelek has not been finalized. The approximate locations (see Figure 2.3-5) are adjacent to stands of native trees (*Pisonia grandis*) in the northern, eastern, and southern portions of the island (see Figure 3.1-10). The potential exists for impacts to these native trees if construction or operational activities result in the removal of more than a few trees or cause a change in environmental conditions (e.g., shading or erosion) that is detrimental to the native trees.

The shock wave and heat generated during a missile launch is likely to be localized and short term, but could have a cumulative effect on the island flora, depending on the magnitude of these events and local weather conditions at the time of each launch. The proposed solid fuel propellants, which burn without noxious fumes (SDIO, 1987), are not expected to adversely impact the flora. To minimize fire risk, USAKA range safety procedures require that all vegetation in the vicinity of the pad be removed. For smaller missiles, such as met rockets, a radius of 50 feet is usually required. For the larger ERIS-type missiles (the type expected to be used for the GSTS launches), a wider radius may be needed. The use of a chemical washdown at the launch pad could be toxic to nearby vegetation. However, missile operations at Kwajalein Atoll are not predicted to result in significant adverse, direct effects to the physical environment (SDIO, 1987).

Construction and renovation projects at Meck, Roi-Namur, and Kwajalein Islands will not have significant adverse impacts to island flora. All these projects occur in disturbed areas that have no native or other important vegetation.

4.5.1.3 Change of Duration Alternative

The potential impacts for this alternative are the same as those for the Proposed Action.

4.5.1.4 Mitigation

Mitigation measures for the Proposed Action and the Change of Duration Alternatives include selecting a site for the missile facilities that will minimize direct and indirect adverse impacts to the areas with native trees on Omelek Island. If some trees must be removed, either for construction or for fire safety requirements, consideration should be given to transplanting rather than destroying these trees. Other measures include constructing barriers between the proposed facilities and the native trees if the proximity of the launch site could result in heat and/or shock damage to the trees. If a chemical washdown is used on the launch pad, practices or structures should be used to neutralize the chemicals or prevent them from reaching the trees or nearby soil.

4.5.1.5 Irreversible or Irretrievable Commitment of Resources

The use of the land on Omelek Island for the proposed missile sites does not constitute an irreversible or irretrievable commitment of resources. The proposed facilities could be removed and native vegetation from nearby stands could be replanted on the sites.

Because the native trees are a biological and thus renewable resource, there would be no long-term decline in production or numbers if the Proposed Action caused an insignificant impact to the stand on Omelek Island. A significant impact to the Omelek Island population could represent a localized loss, but would have little impact to the population of native trees outside of Kwajalein Atoll.

4.5.2 BIRDS AND OTHER ISLAND FAUNA

Potential Areas of Concern

Areas of concern for proposed construction and renovation sites on USAKA islands consist primarily of seabird nesting sites and the habitat of coconut crabs (*Birgus latro*) on Roi-Namur Island.

Levels of Significance

Impacts are considered significant if they interfere or prevent seabird nesting activities; kill nesting seabirds, eggs, or chicks; or destroy seabird nesting habitat. Impacts to coconut crabs are significant if they destroy habitat or reduce harvest to below sustainable yields.

- No or Negligible Impact. Impacts are negligible if no seabirds are killed, if nesting activities are not interrupted, and if nesting habitat is

undisturbed. Little or no change would occur in the number or habitat of coconut crabs.

- Insignificant Impact. Impacts are insignificant if some disturbance in seabird nesting activities occurs and if a few eggs are lost. Effects on coconut crabs are insignificant if removal of their habitat and increase in harvesting does not reduce the number of coconut crabs below sustainable yield.

- Significant Impact. Impacts are significant if all seabird nesting activities on an island are disrupted, if sustainable numbers of seabirds or their eggs are killed, or if nesting habitat is destroyed. Significant impacts on coconut crabs would occur if sufficient habitat were removed or harvest were high enough to reduce the number of coconut crabs to below a sustainable yield.

4.5.2.1 No-Action Alternative

Chapter 3, Section 3.5, describes existing conditions of seabirds and coconut crabs.

4.5.2.2 Proposed Action

The Proposed Action includes construction of missile facilities on Omelek Island to support the GSTS program. The exact siting has not been finalized, but the potential exists for impacts to seabirds (e.g., black-naped terns [*Sterna sumatrana*]) that may nest on Omelek if construction activities destroy nest sites or interrupt nesting activities. In addition, operational activities such as the noise, heat, and shock waves associated with missile launches could interfere with nesting, frighten away seabirds, or lead to direct or indirect death of adult seabirds, eggs, and chicks, depending on whether seabirds actually nest near the site and on how the birds adapt to these activities. These impacts would occur only if in fact nest sites are located at or near the site of the proposed construction. Impacts could be avoided by siting the construction in areas not used for nesting.

Construction and renovation projects proposed for Meck, Roi-Namur, and Kwajalein Islands will have no significant direct adverse impacts to island fauna. These projects are in disturbed areas that have no important habitats or animal populations. However, a higher level of population and activities at Roi-Namur could increase pressure on the remaining coconut crabs on that island by increasing harvesting and disturbance of their habitat.

4.5.2.3 Change of Durati·,n Alternative

The potential impacts for this alternative are the same as those for the Proposed Action.

4.5.2.4 Mitigation

Because no significant impacts are identified, no mitigation is proposed.

4.5.2.5 Irreversible or Irretrievable Commitment of Resources

No irreversible or irretrievable commitment of resources would occur because no direct impact on seabirds or coconut crabs is predicted. Moreover, the populations of those species present on Omelek and Roi-Namur are a very small percentage of the species total population.

4.6 MARINE BIOLOGICAL RESOURCES

Potential Areas of Concern

The marine resources potentially affected by the action alternatives are coral reef habitat or marine plants and animals.

Potential areas of concern include the nearshore environment of USAKA islands, especially Kwajalein, Roi-Namur, Omelek, and Meck (the locations of proposed construction); the mid-atoll corridor lagoon impact area; and the BOA northeast of the atoll.

Levels of Significance

Significance is based on the extent to which the Proposed Action results in loss or major damage to coral reefs and the potential of the reef resource to recover. It is also based on the extent to which there is a potential decline in the productivity and access to nearshore fishery resources based on increasing USAKA populations and the destruction of reef habitat.

- No or Negligible Impact. No measurable destruction of reef habitat requiring long-term recovery. Little or no habitat loss cr physical removal of coral. No decline in the catch per unit of fishing effort.

- Insignificant Impact. Loss of only a few coral colonies, allowing full recovery within 5 years. Some coral reef fish habitat is destroyed, but not

to the extent that there would be a noticeable decline in catch-per-unit effort.

- Significant Impact. Modification of habitat from hard to soft substratum delaying indefinitely or preventing coral reef recovery. The reef habitat around USAKA is reduced to the extent that a noticeable decline in the catch-per-unit effort is predicted.

4.6.1 No-Action Alternative

Harbor areas at USAKA islands have been dredged and quarrying currently occurs at Kwajalein and Roi-Namur. Dredging occurs on an as-needed basis as requirements develop and as funds become available. Chapter 3, Section 3.2, Land and Reef Areas, describes existing conditions and related quarrying and dredging activities.

4.6.2 Proposed Action

The proposed SDI activities at USAKA would have the following incremental impacts on marine plant and animal species.

Quarrying. Quarrying would continue on the oceanside reefs of Kwajalein and Roi-Namur Islands. The proposed Meck quarry would be located on the southeast side of the island (see Figure 3.1-4) and would consist of rectangular (300 feet by 250 feet) and triangular (150 feet by 650 feet by 675 feet) sites. Assuming that the maximum depth of these quarries is the 13-foot depth suggested to minimize sediment accumulation (Titgen, et al., 1988), a total volume of about 60,000 cubic yards would be removed. This is similar to the 62,500 cubic yards quarried at USAKA in 1988 (see Chapter 3, Subsection 3.2.2.3), where no adverse environmental impacts were reported.

Impacts from quarrying would be short term and localized. Short-term impacts would include the loss of the coral quarried and the associated, attached marine plants and animals. Quarrying activities would reduce water quality by causing siltation and increased turbidity. Increased siltation and turbidity, if excessive, can smother and kill living coral and reduce vitality and the growth rate by abrasion and burial.

Where explosives are used in quarrying, anticipated short-term impacts include localized fish and invertebrate kills, dislodging or shattering of coral, increased predation on injured fish by predatory species such as sharks, and a temporary reduction in water quality.

In the long term, inactive quarries can provide a productive habitat for coral and associated marine plants and animals,

as demonstrated by the rich biota of the old Japanese quarries on Kwajalein and the abandoned Meck quarry.

Dredge and Fill Operations. Fill would be required for the proposed new breakwater at Meck Island (approximately 15,000 square feet) on the southwest side of the island (see Figure 2.3-4). The harbor area would require maintenance dredging in conjunction with the construction of the breakwater, and would be dredged approximately every 10 years thereafter.

Direct impacts of fill activities include the burial of plants and animals caused by siltation. Impacts would be reduced because the fill and dredge activities would be located in sandy areas and no coral reefs would be buried. Impacts from fill and dredging activities would be short term, localized, and not significant.

Siltation caused by harbor improvement projects associated with the GSTS program at Omelek Island potentially could affect the rich coral reef biota located on the protected side of the southern jetty on the western side of the island (see Figure 3.1-10). In addition, any pier modifications that disturb the coral communities or realign the jetties at Omelek might cause significant impacts.

Missile Activities. The laying of a fiber optic cable from Meck to Omelek for the proposed GSTS launches at Omelek could disturb coral reef habitat if a trench is dug. This impact, however, would be short term, localized, and not significant.

Reentry vehicles that land in the lagoon or BOA are not expected to have any significant impacts on the marine environment because they involve relatively small amounts of material and generally do not include toxic or hazardous materials (other than small amounts of lithium batteries).

Wastewater Treatment. The construction of the wastewater treatment plant proposed for Roi-Namur Island would have no significant adverse impacts on marine biota. Construction activities required to extend the current outfall pipe would have only minor, short-term localized impacts to the benthic biota of the immediate area. Operation of the proposed facility is expected to have a significant beneficial impact to the marine environment of the area because waste from the Roi side of Roi-Namur, which is not currently being treated, would receive treatment. (See Subsections 4.3.2, Marine Water Quality and 4.12.4, Hazardous Materials and Waste, for a more complete description of marine water quality impacts.)

4.6.3 Change of Duration Alternative

The potential impacts for this alternative are the same as those for the Proposed Action.

4.6.4 Mitigation

Proposed Action

Fill and Dredging. When Omelek Island is refurbished for GSTS, any reconstruction of the pier and jetty should be performed in a manner to avoid permanent, significant damage or destruction to the coral community on the jetty, for instance, by using a silt curtain or other measures to limit siltation.

Change of Duration Alternative

Mitigation is the same as that for the Proposed Action.

4.6.5 Irreversible or Irretrievable Commitment of Resources

Although reef rock is a renewable resource, it is unlikely that the proposed quarries would recover rapidly enough to be mined for rock within the next 500 to 1,000 years. The fill material for the breakwater on Meck Island would not be available for other uses.

4.7 RARE, THREATENED, OR ENDANGERED SPECIES

Potential Areas of Concern

The potential areas of concern include the marine and terrestrial habitats of Kwajalein Atoll.

Level of Significance

Concerns for rare, threatened, or endangered species include loss of remaining giant clams (*Tridacna Gigas*); disturbance of sea turtles, i.e., the threatened green (*Chelonia mydas*) and the endangered hawksbill (*Eretmochelys imbricata*); or loss of sandy beaches suitable for turtle nesting. An additional concern includes removal of rare seagrass (*Halophila minor*).

Levels of Significance

- No or Negligible Impact. This level of significance would be represented by no decline in either the numbers or reproductive viability of the remaining giant clams of the species *T. gigas*.

There would be no decline in the coverage of seagrass beds at USAKA, no change to sandy beach habitat, and no disturbance of turtles or removal of eggs.

- Insignificant Impact. Indicators for insignificant impacts include: water quality changes that inhibit reproductive viability of clams without affecting population survival; loss of 10 percent (or less) coverage of seagrass beds; short-term modification of sandy beach habitat through revetments, installation of facilities, or other semipermanent structures; human contact with turtles that does not affect nesting or feeding behavior.

- Significant Impact. Significant impacts include the removal of any giant clam *T. gigas* or the destruction of its habitat through degraded water quality or reef destruction; destruction of seagrasses leading to more than 10 percent loss of beds off Kwajalein or Roi-Namur Islands; permanent loss of preferred sandy beach turtle nesting habitat (e.g., beaches at Ennylabegan); capture of turtles within USAKA; or disturbance of turtles leading to decline in nesting activity or loss of adult turtles.

4.7.1 No-Action Alternative

The No-Action Alternative may affect two rare species (seagrass and giant clams); one endangered species (hawksbill turtle); and one threatened species (green sea turtle). Maintenance dredging in the area of Kwajalein and Roi-Namur has the potential to impact seagrass. Giant clams may be affected by activities near Gellinam. Thermal effluents have the potential to attract sea turtles, causing increased contact with humans and possible ingestion of debris. However, no sea turtle sightings have been reported from the vicinity of thermal outfalls at USAKA. The current status of threatened, rare, or endangered species at USAKA is described in Section 3.7.

4.7.2 Proposed Action

The proposed SDI activities at USAKA could have impacts on rare species.

If recreational diving increases, there could be an associated growth in collecting pressure on the remaining giant clams in USAKA waters. Because of their current low abundance, this could be a significant impact.

Descriptions of the proposed actions were forwarded to USFWS and NMFS for review. Both agencies agreed that the proposed

actions would not adversely affect threatened or endangered species. The National Marine Fisheries Service recommended certain precautions, however, to minimize the potential for any adverse impacts. These precautions are:

- Quarry sites should be surveyed prior to each day's operations to ensure that no turtles are present.

- Quarry blasting should be restricted to the smallest practical charge.

- Blasting should be delayed until any turtles are outside a 100-meter radius from the blasting area.

- Any injuries or deaths of turtles caused by construction, blasting, or quarrying should be reported to NMFS.

The addition of Power Plant 1A would require 4,800 gpm of additional cooling water, which would be discharged as thermal effluent into lagoon waters where turtles have been sighted. Sea turtles are attracted to thermal discharges, which may contribute to increased contact with humans or ingestion of associated debris (G. Nitta, Pacific Islands Endangered Species Coordinator, personal communication). However, no turtle sightings have been reported in the vicinity of thermal outfalls at USAKA.

4.7.3 Change of Duration Alternative

The potential impacts for this alternative are the same as those for the Proposed Action.

4.7.4 Mitigation

The following mitigation measures are proposed for impacts of the Proposed Action or Change of Duration Alternative for the rare species of Kwajalein Atoll:

- Promulgate a USAKA regulation based on RMI Environmental Protection Agency regulations that prohibits the taking of *T. gigas* giant clams at USAKA.

- Consideration should be given to locating and transplanting giant clams when proposed USAKA marine construction activities could potentially be damaging to the species.

- USAKA could consider transplanting immature giant clams from aquaculture facilities to Kwajalein Atoll.

4.7.5 Irreversible or Irretrievable Commitment of Resources

Threatened, rare, or endangered species of USAKA islands are not expected to decline if the proposed mitigation measures are implemented.

4.8 ARCHAEOLOGICAL/CULTURAL/HISTORICAL RESOURCES

Archaeological, historical, and cultural resources consist of the material remains of human activity significant in the history, prehistory, architecture, or archaeology of the USAKA area. These remains include buildings, structures, and objects that possess qualities of location, design, setting, materials, or workmanship that associate them with Marshall Islands history, architecture, archaeology, and culture. The following list includes further definitions:

- They are associated with events that have made a contribution to the broad patterns of history (e.g., Kwajalein and Roi-Namur Island Battlefield National Landmark sites).

- They are associated with the lives of persons significant to the American and/or Marshallese past (e.g., American World War II battle commanders and significant locations in Marshallese oral history).

- They embody the distinctive characteristics of a type, period, or method of construction or that represent a distinguishable entity whose components may lack individual distinction (e.g., particular Japanese-era structures indicative of pre-World War II construction on isolated tropical Pacific Islands, possible Marshallese traditional gravesites, and homestead areas such as those on Ennylabegan and Legan Islands).

- They have yielded, or may be likely to yield, information important in prehistory or history (e.g., burned World War II structural footings or prehistoric Marshallese cultural deposits).

Affected resources include significant or potentially significant resources that may be affected by the action alternatives. Resources are considered under two headings: prehistoric resources and historic resources.

4.8.1 PREHISTORIC RESOURCES

Potential Areas of Concern

Potential areas of concern include cultural resources that were produced by the preliterate, indigenous people of the USAKA area and that are of archaeological interest (e.g., the possible Marshallese gravesites on Omelek Island).

The significance of impacts to prehistoric archaeological resources was evaluated in reference to the criteria used for nomination to the U.S. National Register of Historic Places. These signifance criteria were adapted to the particular ecological and social conditions prevalent in RMI and at USAKA.

Levels of Significance

- No or Negligible Impact. No adverse impact is expected and/or the level of impact is expected to be so slight that it will not affect a particular cultural property.
- Insignificant Impact. Potential adverse impacts are probable, but no substantial consequences are expected that would affect the condition of the cultural property.
- Significant Impact. The Proposed Action would have a substantial adverse effect on existing cultural resources, resulting in the destruction or alteration of that resource.

4.8.1.1 No-Action Alternative

Existing conditions of environmental impacts on prehistoric resources are described in Chapter 3, Section 3.8.

4.8.1.2 Proposed Action

The proposed construction of the GSTS facilities on Omelek could have a significant adverse effect on the possible gravesites located on the western portion of the island. Portions of the facility (Expanded Launch Pads) are situated near the archaeological resource and could result in its destruction, depending on the size and exact location of the facilities as finally designed. The proposed Unaccompanied Personnel Housing on Kwajalein Island may adversely impact archaeological resources because it is within an area (the original northern land area of the island) with the potential for archaeological resources (the possible prehistoric cultural soil/sediment observed in this area). The construction of the sewage treatment plant on Roi-Namur would probably not affect archaeological resources because the

area is already heavily disturbed and exhibits a low potential for archaeological resources. No impact to resources is predicted on Meck Island.

Increased use and accessibility of Omelek may result in a degradation of the archaeological resource in addition to that which might be caused by construction.

4.8.1.3 Change of Duration Alternative

The impacts of this alternative are the same as those for the Proposed Action.

4.8.1.4 Mitigation

Preconstruction sampling of the Omelek GSTS site should be conducted to determine the likely extent, nature, and significance of the resource. If significant and if the proposed facilities at the archaeological site on Omelek cannot be located to avoid damage to the site, a preconstruction archaeological data recovery program consisting of intensive survey, site mapping, controlled test excavation, and data analysis and recordation should be performed. Archaeological monitoring with systematic sampling should accompany the construction of the facilities on Kwajalein and Roi-Namur, delineated above.

4.8.1.5 *Irreversible or Irretrievable Commitment of Resources*

No irreversible or irretrievable commitments of resources are expected if the proposed mitigation actions are implemented.

4.8.2 HISTORICAL RESOURCES

Potential Areas of Concern

Potential areas of concern are the cultural resources or historic sites that were established since the advent of written records in the USAKA area that are of archaeological and/or historical interest (e.g., the World War II facilities on Roi-Namur Island that are included in the National Register of Historic Places).

Levels of Significance

Significance of the impacts to the resource is based on the likelihood of destruction, degradation, or loss of significant characteristics of historic-era resources, particularly those associated with the Japanese World War II structural remains. Most of these resources are contained within the National Historic Landmark sites on Roi-Namur and Kwajalein.

- No or Negligible Impact. No adverse impact is expected, or impact will be slight and will not affect the condition of the historical resource.

- Insignificant Impact. Adverse impact is expected to partially affect the condition of the historical resource.

- Significant Impact. The impact is expected to substantially alter or destroy the historical resource.

4.8.2.1 No-Action Alternative

Existing conditions of historical resources are described in Chapter 3, Section 3.8.

4.8.2.2 Proposed Action

Potential subsurface historical resources may be directly affected on Kwajalein and Roi-Namur Islands due to the proposed construction projects on those islands. These proposed construction projects include the package sewage treatment plant on Roi-Namur and unaccompanied personnel housing on Kwajalein. No direct impacts to historical resources are predicted on other islands.

Increased resident population on Kwajalein and Roi-Namur could have an indirect effect on historical resources through increased potential for public disturbance.

4.8.2.3 Change of Duration Alternative

The impacts of this alternative are the same as those for the Proposed Action.

4.8.2.4 Mitigation

All ground-disturbing activities should avoid known locations of historical resources. Planned new facilities on Roi-Namur should be designed and placed in such a manner that the intrinsic character and significance of the historical remains are not affected. Maintenance activities involving excavation should be archaeologically monitored for historical resources as well as for archaeological resources.

Archaeological monitoring of construction sites for the proposed sewage treatment plant on Roi-Namur and the proposed unaccompanied personnel housing project on Kwajalein is recommended. An educational program explaining the significance and importance of the historical resources to the increased resident population may deter damage to the resource.

4.8.2.5 Irreversible or Irretrievable Commitment of Resources

No irreversible or irretrievable commitments of resources are expected if the proposed mitigation measures are implemented.

4.9 LAND USE

Potential Areas of Concern

The Proposed Action and Change of Duration Alternative include the construction of new facilities. Land uses could be affected if facilities are sited in locations where they create conflicts among existing or planned uses.

Levels of Significance

Land use impacts are considered significant if the proposed uses are incompatible with existing or planned uses, as identified in facility planning studies for USAKA. Planning studies include concept plans developed as part of the USAKA Master Plan Report, which examine existing land use areas; functional relationships among uses; and future facility requirements. These plans are flexible, and can evolve and be adjusted to respond to USAKA mission requirements.

The following levels of significance are defined for use in evaluating the proposed actions:

- No or Negligible Impact. Facility siting is considered to have no impact on land use if the new facility is sited in an area where the new use is entirely compatible with the area's existing or planned use (i.e., would not cause health or safety hazards or nuisances).

- Insignificant Impact. Facility siting is considered to have an insignificant impact on land use if the new facility is sited in an area where the new use is largely compatible with the existing or planned use, and the few incompatible elements would cause no health or safety hazards and minimal nuisances.

- Significant Impact. Facility siting is considered to have a significant impact on land use if the new facility is sited in an area where the new use is incompatible with existing or planned uses (i.e., would cause health or safety hazards or nuisances).

4.9.1 No-Act:on Alternative

See Chapt^r 3, Section 3.9 for a description of existing land uses at USAKA.

4.9.2 Proposed Action

There are no conflicts between the Proposed Action and applicable land and airspace use, plans, policies, and controls for USAKA.

Kwajalein

The construction projects proposed on Kwajalein Island are all proposed to be constructed in areas with similar uses. The unaccompanied personnel and family housing projects would be located in established housing and community support areas toward the eastern side of the island (see Figures 2.3-2 and 3.9-1). The desalination plant would be located adjacent to an existing power plant. The GBR-X facility would be located in an area containing communications and supply facilities at the western end of the island. The ERIS/HEDI warehouse would be located in an area used for research and development and supply facilities.

Roi-Namur

The two construction projects proposed to be sited on Roi-Namur would be located in areas with similar uses (see Figures 2.3-3 and 3.9-2). The new package sewer treatment plant would be in an area on the western side of Roi now used for research and development operations. The proposed document control facility would be located in an area on the northern side of Namur currently used for research and development facilities.

Meck

The proposed HEDI, ERIS, and SBI launch facilities on Meck Island are compatible with the existing and planned uses of Meck Island, which is entirely devoted to missile launches and other mission support activities (see Figures 2.3-4 and 3.9-3). The existing temporary housing for the construction crews will be demobilized when construction is complete.

Omelek

Omelek Island is currently used for meteorological rocket launches. The proposed GSTS launch facilities on Omelek would be compatible with the existing use of the island (see Figures 2.3-5 and 3.9-9). Temporary housing for construction workers would be demobilized after construction is complete. Impacts to areas of native vegetation are expected to be minimal (see Section 4.5, Island Plants and Animals).

Other Islands

No construction is proposed on other islands.

4.9.3 Change of Duration Alternative

The schedule modifications in the Change of Duration Alternative do not affect the land use impacts of the Proposed Action.

4.9.4 Mitigation

Because no significant impacts have been identified, no mitigation is required.

4.9.5 Irreversible or Irretrievable Commitment of Resources

Because land area at USAKA is so limited, most sites have been used for many purposes over the last few decades. As facilities have become obsolete or unneeded, they have been replaced by new facilities. The proposed land uses are not irreversible or irretrievable commitments of resources because the proposed facility sites can be used for other purposes after the proposed mission functions are completed.

4.10 SOCIOECONOMIC CONDITIONS

4.10.1 POPULATION, EMPLOYMENT, AND HOUSING

Potential Areas of Concern

The projected employment, population, and housing implications of the No-Action Alternative, Proposed Action, and Change of Duration Alternative are summarized in Tables 4.10-1, -2, -3, and -4.

Population levels at USAKA vary in direct relation to permanent and temporary nonindigenous employment; these levels directly affect the demand for living accommodations as well as other socioeconomic indicators. Quality of housing, base services, and support facilities are also affected at USAKA when the nonindigenous employment and population increase. On non-USAKA islands, socioeconomic conditions are affected indirectly.

Currently, there is a shortage of adequate family housing and UPH at USAKA that may affect the ability of USAKA and its contractors to recruit and retain personnel (see Tables 4.10-3 and 4.10-4). Increased employment will increase the demand for both family and UPH. This increased demand will exacerbate existing conditions that affect the quality of both family and UPH unless additional housing

Table 4.10-1
ESTIMATE OF NONINDIGENOUS EMPLOYMENT AT USAKA

Description	Fiscal Year 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No-Action Alternative										
Operations employment	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503	1,503
Construction employment	200	200	200	200	200	200	200	200	200	200
Total employment	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703
Proposed Action										
Increase in operations employment	29	59	74	183	183	145	10	10	0	0
Increase in construction employment	50	75	50	50	0	0	0	0	0	0
Total increase in employment	79	134	124	233	183	145	10	10	0	0
Percent of No-Action employment	4.6%	7.9%	7.3%	13.7%	10.7%	8.5%	0.6%	0.6%	0.0%	0.0%
Total operations employment	1,532	1,562	1,577	1,686	1,686	1,648	1,513	1,513	1,503	1,503
Total construction employment	250	275	250	250	200	200	200	200	200	200
Total employment	1,782	1,837	1,827	1,936	1,886	1,848	1,713	1,713	1,703	1,703
Change of Duration Alternative										
Increase in operations employment	29	59	64	61	65	79	63	79	79	69
Increase in construction employment	50	50	75	0	0	0	0	0	0	0
Total increase in employment	79	109	139	61	65	79	63	79	79	69
Percent of No-Action employment	4.6%	6.4%	8.2%	3.6%	3.8%	4.6%	3.7%	4.6%	4.6%	4.1%
Total operations employment	1,532	1,562	1,567	1,564	1,568	1,582	1,566	1,582	1,582	1,572
Total construction employment	250	250	275	200	200	200	200	200	200	200
Total employment	1,782	1,812	1,842	1,764	1,768	1,782	1,766	1,782	1,782	1,772

Source: Information provided by USAKA and USASDC, Huntsville, Alabama.

Table 4.10-2
ESTIMATE OF NONINDIGENOUS POPULATION AT USAKA

Description	Fiscal Year 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No-Action Alternative--Population associated with:										
Operations employment[1]	2,758	2,758	2,758	2,758	2,758	2,758	2,758	2,758	2,758	2,758
Construction employment	215	215	215	215	215	215	215	215	215	215
Total population	2,793	2,793	2,793	2,793	2,793	2,793	2,793	2,793	2,793	2,793
Proposed Action--Population associated with:										
Increase in operations employment	77	121	142	403	403	315	20	20	0	0
Increase in construction employment[2]	54	81	54	54	0	0	0	0	0	0
Total increase in population	131	202	196	457	403	315	20	20	0	0
Percent of No-Action population	4.7%	7.2%	7.0%	16.4%	14.4%	11.3%	0.7%	0.7%	0.0%	0.0%
Total population	2,924	2,995	2,989	3,250	3,196	3,108	2,813	2,813	2,793	2,793
Change of Duration Alternative--Population associated with:										
Increase in operations employment	77	121	126	123	133	137	118	201	201	181
Increase in construction employment[2]	54	54	81	0	0	0	0	0	0	0
Total increase in population	131	175	207	123	133	137	119	201	201	181
Percent of No-Action population	4.7%	6.3%	7.4%	4.4%	4.8%	4.9%	4.3%	7.2%	7.2%	6.5%
Total population	2,924	2,968	3,000	2,916	2,926	2,930	2,912	2,994	2,994	2,974

[1]Includes population associated with accompanied, unaccompanied, and transient personnel, based on December 1988 population. Accompanied personnel are expected to have an average of two dependents, based on historical data.

[2]The construction management personnel may possibly have dependents if they are provided family housing. The construction personnel count is adjusted by a factor based on the number of dependents at USAKA in December 1988.

Source: Information provided by USAKA and USASDC, Huntsville, Alabama.

Table 4.10-3
ESTIMATE OF FAMILY HOUSING NEEDS AT USAKA 1989 TO 1998

Description	Fiscal Year 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No-Action Alternative										
Housing required	555	555	555	555	555	555	555	555	555	555
Existing housing supply units										
Meeting standards[1]	137	137	137	137	137	137	137	137	137	137
Substandard[1]	542	542	542	288	288	288	288	288	288	288
Total existing	679	679	679	425	425	425	425	425	425	425
Net surplus (shortage)	124	124	124	(130)	(130)	(130)	(130)	(130)	(130)	(130)
Proposed Action										
No-Action housing required	555	555	555	555	555	555	555	555	555	555
Additional housing required	24	31	34	110	110	85	5	5	0	0
Total housing required	579	586	589	665	665	640	560	560	555	555
Total existing supply	679	679	679	425	425	425	425	425	425	425
With proposed addition of 130 units										
Meeting standards										
Total meeting standards[1]	137	137	137	267	267	267	267	267	267	267
Total substandard[1]	542	542	542	288	288	288	288	288	288	288
Total proposed supply	679	679	679	555	555	555	555	555	555	555
Net surplus (shortage)	100	93	90	(110)	(110)	(85)	(5)	(5)	0	0
Change of Duration Alternative										
No-Action housing required	555	555	555	555	555	555	555	555	555	555
Additional housing required	24	31	31	31	34	29	28	61	61	56
Total housing required	579	586	586	586	589	584	583	616	616	611
Total existing supply	679	679	679	425	425	425	425	425	425	425
With proposed addition of 130 units										
Meeting standards										
Total meeting standards[1]	137	137	137	267	267	267	267	267	267	267
Total substandard[1]	542	542	542	288	288	288	288	288	288	288
Total proposed supply	679	679	679	555	555	555	555	555	555	555
Net surplus (shortage)	100	93	93	(31)	(34)	(29)	(28)	(61)	(61)	(56)

[1] According to USAKA, there are currently 288 old permanent housing units and 254 trailers that are substandard based on AR 210-50. The 254 trailers are planned to be phased out in FY92. As new family housing becomes available, the trailers could be temporarily used as unaccompanied housing until new unaccompanied housing meeting Army standards is constructed.

Sources: Information provided by USAKA and USASDC, Huntsville, Alabama.

Table 4.10-4
ESTIMATE OF ROOMS REQUIRED BY UNACCOMPANIED PERSONNEL

Description	Fiscal Year 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No-Action Alternative										
Total rooms currently required	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137
Total supply										
Unaccompanied personnel accommodation meeting Army standards[1]										
Existing	520	520	520	520	520	520	520	520	520	520
Programmed modernization of existing 30 units	—	—	—	30	30	30	30	30	30	30
Total existing supply	520	520	520	550	550	550	550	550	550	550
Net surplus (shortage)	(607)	(617)	(617)	(587)	(587)	(587)	(587)	(587)	(587)	(587)
Proposed Action										
No-Action rooms required	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137
Additional rooms required	0	4	10	37	37	33	0	0	0	0
Total rooms required	1,137	1,141	1,147	1,174	1,174	1,170	1,137	1,137	1,137	1,137
Total existing supply	520	520	520	550	550	550	550	550	550	550
Proposed 400-unit addition	—	—	—	400	400	400	400	400	400	400
Net surplus (shortage)	(617)	(621)	(627)	(224)	(224)	(220)	(187)	(187)	(187)	(187)
Change of Duration Alternative										
No-Action rooms required	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137	1,137
Additional rooms required	0	4	4	4	10	25	25	8	8	8
Total rooms required	1,137	1,141	1,141	1,141	1,147	1,162	1,162	1,145	1,145	1,145
Total existing supply	520	520	520	550	550	550	550	550	550	550
Proposed 400-unit addition	—	—	—	400	400	400	400	400	400	400
Total proposed supply	520	520	520	950	950	950	950	950	950	950
Net surplus (shortage)	(617)	(621)	(621)	(191)	(197)	(212)	(212)	(195)	(195)	(195)

[1] USAKA has adopted AR 210-11 and the Army Corps design standards for future conversion and construction of unaccompanied housing. Based on these standards, USAKA will strive toward providing each unaccompanied personnel an individual bedroom with bathroom facilities to be shared by two persons.

Sources: Information provided by USAKA and USASDC, Huntsville, Alabama.

units are provided. USAKA has stated that crowded housing conditions have a negative effect on personnel recruitment and retainment.

Levels of Significance

The levels of significance are based on the following conditions:

Employment--There is an adequate supply of nonindigenous personnel to meet the personnel requirements associated with USAKA's mission. The significance criteria are:

- No or Negligible Impact. Personnel needs will be met without any effect on the USAKA's mission.

- Insignificant Impact. Short-term delays will occur in programs caused by recruitment difficulties, but programs will be completed.

- Significant Impact. Long-term delays will occur in programs, or programs will not be completed because of an inadequate supply of personnel.

Population--No population impact is evaluated in this subsection, because the population impacts of each alternative are reflected in the employment and housing discussion in this section and in Utilities (e.g., water, wastewater, electricity) in Section 3.12.

Housing--The objectives established by USAKA for meeting the standards of AR 210-50 (family housing) and AR 210-11 (unaccompanied housing), and the Army Corps of Engineers design standards for new construction (A-E Instruction-Design Criteria, 14 June 1988) are met. The significance criteria are:

- No or Negligible Impact. Housing will be adequate to meet demand and meet the above-referenced standards.

- Insignificant Impact. The supply of housing is inadequate based on the above-referenced standards; however, the supply of housing is sufficient based on substandard conditions.

- Significant Impact. The supply of housing is insufficient to accommodate the demand for housing even after substandard facilities are used.

4.10.1.1 No-Action Alternative

USAKA employment and population will remain at current levels under the No-Action Alternative (Tables 4.10-1 and

4.10-2). However, the No-Action Alternative entails a continued deficit of standard family housing, continued use of substandard living accommodations for family and accompanied personnel, and a shortage of housing starting in 1992 (Table 4.10-3). There would be a deficit of 130 family units beginning in 1992 when use of 254 substandard trailers is discontinued. There would be a shortage of 617 UPH units meeting Army standards through FY91, decreasing to a shortfall of 587 units after FY91. Impacts are indirect and related to recruitment and retention of permanent employees. USAKA is seeking third-party developers to construct new accommodations under a build-lease agreement.

4.10.1.2 Proposed Action

Table 4.10-3 summarizes the estimated family housing supply and demand for fiscal years FY88 to FY98. This table assumes completion of the proposed 130 new family housing units in FY92 and discontinued use of 254 substandard trailers in FY92. Under the action alternatives, there would be a continued deficit of standard family housing. Beginning in FY92, the Proposed Action would result in a net deficit of 110 family housing units in FY92 and FY93 after the proposed 130 new family units are completed. The shortage would decrease to 85 units in FY94 and to 5 units in FY95 and FY96 when the SDI program would conclude. This reflects a smaller impact on family housing than the No-Action Alternative (assuming the proposed 130 units are completed by 1992).

Table 4.10-4 shows UPH needs and compares the expected demand and supply. The proposed 400 new UPH units are assumed to be funded and available in FY92. The Proposed Action would result in a net total deficit of 627 units in FY91, 24 units in FY92 and FY93, and 220 units in FY94. From 1995 through 1998, the total deficit would be 187 units. For the duration of the Proposed Action, the crowding of personnel into a less-than-authorized area would be only partially relieved by completion of the 400 units in 1992. The remaining deficit represents a significant impact because there would not be an adequate supply of housing to meet demand through 1998.

The positions associated with the Proposed Action will require individuals with highly technical backgrounds and security clearances. Efforts are in place to identify prospective personnel who will provide an adequate supply of qualified candidates to meet the objectives of the Proposed Action. The Marshallese workforce at USAKA, which includes wage and salaried employees, is expected to remain at nearly the same level as in late FY88, (approximately 950 employees). As mentioned in Section 3.10, an estimated 684 Marshallese currently residing in the Kwajalein Atoll are potential employees for any new jobs in the atoll.

Additional domestics, drawn from the existing population, may be hired by individual USAKA residents. No changes in the population levels or population density of Marshallese at Kwajalein Atoll are expected to occur as a result of implementation of the Proposed Action. As construction activity at Roi-Namur is completed in FY92, some of Ennubirr's current residents may move elsewhere in the atoll or the RMI. Other changes in population density in the non-USAKA islands of Kwajalein Atoll that might occur in the future are expected to be due to causes outside of USAKA's control or responsibility.

4.10.1.3 Change of Duration Alternative

Table 4.10-3 indicates that, compared with the No-Action Alternative, the Change of Duration Alternative would increase the family housing shortfall by an increment of 31 units in FY90 to FY92 and 34 units in FY93. After FY93, the housing shortage is reduced by the Change of Duration Alternative assuming the 130 family housing units are completed by 1992. The deficit of UPH would be greatest (621) in FY90 and FY91 and drop to 212 in FY94 and FY95 and 195 in FY96 to FY98. Compared with the Proposed Action, the Change of Duration Alternative would be reduced in the short term and increased in the long term for both family and unaccompanied housing. This represents a significant impact because there is not an adequate supply of housing to meet demand through 1998.

4.10.1.4 Mitigation

USAKA has adopted AR 210-50 (family housing), AR 210-11 (unaccompanied housing), and the Army Corps of Engineers design standards for housing requirements. USAKA seeks to provide each unaccompanied person with an individual bedroom and a bathroom to be shared by two persons, a standard that is compatible with housing space requirements for new construction defined by the U.S. Army Corps of Engineers (A-E Instruction-Design Criteria, 14 June 1988). The construction of 130 family housing units and 400 UPH in FY92 with temporary retention of some old trailers will provide sufficient housing. Some substandard housing conditions will remain in both family housing and UPH.

4.10.2 INCOME AND FISCAL CONDITIONS

Potential Areas of Concern

Under the No-Action Alternative, as noted in Chapter 3, USAKA is the predominant force in the economy of Kwajalein Atoll. Because USAKA activities would be increased under the action alternatives, it is assumed that any effects on the income and fiscal condition of both USAKA and Kwajalein Atoll would be positive.

Levels of Significance

Because tax receipts from USAKA employees form an important part of the RMI fiscal revenues, these can be used to evaluate the potential effect of the two action alternatives. The significance criteria are:

- No or Negligible Impact. USAKA-based tax receipts to the RMI government do not change from current levels.
- Insignificant Impact. USAKA-based tax receipts to the RMI government change up to 5 percent from current levels.
- Significant Impact. USAKA-based tax receipts to the RMI government change more than 5 percent from current levels.

4.10.2.1 No-Action Alternative

Chapter 3, Section 3.10, describes existing socioeconomic conditions. Current contract personnel (operations and construction) pay an average of $1,900 per year to the RMI government in taxes (a 5 percent income tax). The total USAKA-based tax receipt for 1989 was $3.3 million. This is not anticipated to change with the No-Action Alternative.

4.10.2.2 Proposed Action

Under the Proposed Action, the Marshallese economy, compared with the No-Action Alternative, would be positively affected by a rise in revenues from the 5 percent income tax on the salaries of nonindigenous contract employees. In FY88, tax collections derived from USAKA contract personnel averaged $1,900 per contract personnel. Based on this average, the Proposed Action could contribute up to an additional $400,000, for a total of approximately $3.7 million in the peak year of FY92. Tables 4.10-5 and 4.10-6 show that in FY89, the local economy of USAKA would be positively affected by the additional tax receipts resulting from the increase of USAKA employment. In the peak employment year, FY92, the nonindigenous employment at USAKA is predicted to increase by 13.7 percent and tax receipts to the RMI government are predicted to increase by 12 percent. Beyond FY95, there would be no impact.

4.10.2.3 Change of Duration Alternative

Tables 4.10-5 and 4.10-6 show that the Change of Duration Alternative causes the beneficial impacts of tax receipts to be reduced but extended compared with the Proposed Action.

Table 4.10-5
USAKA NONINDIGENOUS CONTRACT EMPLOYEES
NUMBER OF CONTRACT PERSONNEL
(Operations and Construction)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No-Action	1,753	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703
Proposed Action	1,782	1,837	1,827	1,936	1,886	1,848	1,713	1,713	1,703	1,703
Change of Duration Alternative	1,782	1,812	1,842	1,764	1,768	1,782	1,766	1,782	1,782	1,772

Table 4.10-6
INCOME TAX RECEIPTS TO THE RMI GOVERNMENT FROM USAKA NONINDIGENOUS CONTRACT EMPLOYEES

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Tax Receipts[a]										
No-Action ($ million)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Proposed Action ($ million)	3.4	3.5	3.5	3.7	3.6	3.5	3.3	3.3	3.3	3.3
Percent Increase over No-Action	3	6	6	12	9	6	0	0	0	0
Change of Duration Alternative ($ million)	3.4	3.4	3.5	3.4	3.6	3.4	3.4	3.4	3.4	3.4
Percent Increase over No-Action	3	3	6	3	9	3	3	3	3	3

[a] Assuming $1,900 average tax per employee.

PD439.003.1

4.10.2.4 Mitigation

Because only insignificant or beneficial impacts are predicted, no mitigation is required.

4.10.3 RECREATION, EDUCATION, AND PUBLIC HEALTH

Potential Areas of Concern

Potential areas of concern include effects on recreation, education, and public health.

Levels of Significance

The significance of potential impacts on the above conditions are identified at three levels.

- No or Negligible Impact. There are sufficient existing or planned facilities relative to demand to contribute to positive morale of USAKA personnel.

- Insignificant Impact. Deficiencies in facilities relative to demand contribute to personnel morale problems.

- Significant Impact. Deficiencies in facilities relative to demand affect the recruitment of new and the retention of existing USAKA employees and delays occur in programs.

4.10.3.1 No-Action Alternative

Existing conditions are described in Chapter 3, Section 3.10.

4.10.3.2 Proposed Action

There would be no direct impacts from the Proposed Action on recreation, education, or health. The additional population is not expected to exacerbate the existing lack of child-care facilities and the current insufficient capacity at the USAKA preschool. No other recreational or health facilities or services would be significantly affected. The Proposed Action would not affect recreation, education, or health conditions at Ebeye or Ennubirr, or for the Marshallese who use these facilities and services at USAKA.

4.10.3.3 Change of Duration Alternative

The demand on education, health, and recreation services would be slightly lower but extend over a longer period than in the Proposed Action. No significant impacts are anticipated.

4.10.3.4 Mitigation

Because no recreation, education, or public health issues at USAKA or at Ebeye and Ennubirr would be significantly affected by the two action alternatives, no mitigation is required.

4.11 TRANSPORTATION

4.11.1 AIR TRANSPORTATION

Potential Areas of Concern

Transportation is one of the vital components of the human environment at USAKA. The alternatives potentially affect the number of mainland flights, number of inter-island trips, and airspace safety.

Levels of Significance

- No or Negligible Impact. There would be no significant changes in either the service provided or safety factors.
- Insignificant Impact. Some small but measurable impacts on the level of service occur; however, federal standards and regulations are met and there is no effect on safety.
- Significant Impact. Impacts are significant if they degrade safety or do not meet federal standards and regulations.

4.11.1.1 No-Action Alternative

Under the No-Action Alternative, air transportation operations would continue as they are at present. Operations are currently at capacity for the size of the fleet and the maintenance personnel available.

4.11.1.2 Proposed Action

Kwajalein. As shown in Table 4.11-1, both the number of MAC flights from the mainland and inter-island SD3-30 flights would increase as the transient population of the atoll increases. The projected increase in operations would not exceed the capacity of the Bucholz Airfield. However, because existing programs use all available aircraft and personnel, direct effects of this increase would include the need for one additional SD3-30 to meet the increased level of operations. This is a negligible impact.

Table 4.11-1
PROJECTION OF MONTHLY FLIGHT ARRIVALS AND DEPARTURES
PROPOSED ACTION

Operation	Type of Aircraft	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
MAC	C-141	32	33	33	34	36	36	35	32	32	32	32
Air Micronesia	B-727	68	68	68	68	68	68	68	68	68	68	68
Transient AC:												
USAF	C-130	6	6	6	6	7	7	7	6	6	6	6
USAF	C-141	6	6	6	6	7	7	7	6	6	6	6
USN	C-12	2	2	2	2	2	2	2	2	2	2	2
AMI	DO-228	66	66	66	66	66	66	66	66	66	66	66
AMI	HS-748	28	28	28	28	28	28	28	28	28	28	28
COE	G-II	2	2	2	2	2	2	2	2	2	2	2
FAA	B-727	4	4	4	4	5	5	4	4	4	4	4
USMC	C-130	6	6	6	6	7	7	7	6	6	6	6
AUSTRALIA	P-3	4	4	4	4	4	4	4	4	4	4	4
AUSTRALIA	C-130	2	2	2	2	2	2	2	2	2	2	2
JAPAN	C-130	4	4	4	4	4	4	4	4	4	4	4
USAKA AIRCRAFT	UH-1H/B-214[a]	618	416	422	425	462	462	450	408	408	405	405
	SD3-30	703	732	743	748	812	812	791	718	718	703	703

[a]UH-1H assumed to be replaced by the Bell 214ST by 1990. The Bell 214ST has approximately 50 percent more capacity than the UH-1H.

Also affected directly by this Proposed Action would be the amount of aircraft parking and fueling facilities, and the use of "hot spots" for the handling of explosives transported by air. Adequate parking and fueling facilities currently exist to meet the needs of this Proposed Action. The use of the hot spot areas would need to be scheduled to relieve potential delays in the handling of explosives. These impacts are, therefore, considered negligible.

The relatively short-term use of the airspace and airport facilities by the Proposed Action could enhance the long-term airport capabilities. This would result from the additional logistics equipment that would remain after the program has been concluded. Beyond these minor changes, the airport environment is not expected to realize any short-term or long-term environmental gains or losses.

Roi-Namur. Dyess Army Airfield on Roi-Namur would also experience increased air traffic operations. Because the majority of personnel are ferried from Kwajalein, USAKA aircraft, such as the Shorts SD3-30, are already operating at capacity. The additional personnel required with the Proposed Action would generate a need for one additional aircraft. This is considered to be a negligible impact.

Other Islands. The helipads on Meck, Ennylabegan, Legan, Illeginni, Gagan, Gellinam, Omelek, and Eniwetak Islands are capable of handling the air transportation needs of the Proposed Action without modification. The increased level of operations for all islands can be handled by the existing facilities.

Net or residual impacts to the environment as a result of changes to the air transportation system with the Proposed Action are very limited and insignificant.

4.11.1.3 Change of Duration Alternative

The Change of Duration Alternative would have essentially the same program elements as the Proposed Action, but they would occur over a longer period of time. The estimated monthly flight operations of the alternative are given in Table 4.11-2. Some of the negligible impacts of the Proposed Action would be further eased by this alternative. The need for additional aircraft would not be as severe or as immediate as for the Proposed Action. Therefore, there are no significant impacts with the Change of Duration Alternative.

Table 4.11-2
PROJECTION OF MONTHLY FLIGHT ARRIVALS AND DEPARTURES
CHANGE OF DURATION ALTERNATIVE

Operation	Type of Aircraft	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
MAC	C-141	32	33	33	33	33	33	34	33	34	34	34
Air Micronesia	B-727	68	68	68	68	68	68	68	68	68	68	68
Transient AC:												
USAF	C-130	6	6	6	6	6	6	6	6	6	6	6
USAF	C-141	6	6	6	6	6	6	6	6	6	6	6
USN	C-12	2	2	2	2	2	2	2	2	2	2	2
AMI	DO-228	66	66	66	66	66	66	66	66	66	66	66
AMI	HS-748	28	28	28	28	28	28	28	28	28	28	28
COE	G-II	2	2	2	2	2	2	2	2	2	2	2
FAA	B-727	4	4	4	4	4	4	4	4	4	4	4
USMC	C-130	6	6	6	6	6	6	6	6	6	6	6
AUSTRALIA	P-3	4	4	4	4	4	4	4	4	4	4	4
AUSTRALIA	C-130	2	2	2	2	2	2	2	2	2	2	2
JAPAN	C-130	4	4	4	4	4	4	4	4	4	4	4
USAKA	UH-1H/B-214[a]	618	416	422	423	423	423	425	422	434	434	431
AIRCRAFT	SD3-30	703	732	743	744	743	747	747	741	762	762	757

[a]UH-1H assumed to be replaced by the Bell 214ST by 1990. The Bell 214ST has approximately 50 percent more capacity than the UH-1H.

4.11.1.4 Mitigation

Because no significant impacts have been identified, no mitigation is required.

4.11.2 GROUND TRANSPORTATION

Potential Areas of Concern

The alternatives potentially affect the condition of the roadways, the level of service, the number of vehicles, the number of bus and shuttle trips, and the amount of bicycle and pedestrian travel.

Levels of Significance

- No or Negligible Impact. No increase in traffic on roadways. No increase in the inventory of vehicles or the operation of vehicles.

- Insignificant Impact. Increase in traffic volume up to the capacity of existing roadways. Increase in vehicles or operation of vehicles to no more than 25 percent of existing use.

- Significant Impact. Increase in traffic volume on the roadways beyond the capacity of the roads and/or increase in the inventory of vehicles or the operation of the vehicles by more than 25 percent over existing conditions.

4.11.2.1 No-Action Alternative

Under the No-Action Alternative, ground transportation would continue as at present. The vehicle fleet is currently operating at capacity for the number of vehicles and the maintenance personnel available. According to USAKA transportation staff, the fleet is operating without problems.

4.11.2.2 Proposed Action

Kwajalein. Under the Proposed Action, the number of vehicles required would increase, as well as the number of trips. Tables 4.11-3 and 4.11-4 summarize the increase in vehicles and miles of operation anticipated for the Proposed Action. The projected increase in traffic as a result of these additional vehicles would not exceed the capacity of the roadways, as a street similar to those on Kwajalein can carry up to 2,000 vehicles per hour. Because of the small number of vehicles allowed on the island, traffic would not approach this volume. The current street system operates at

Table 4.11-3
PROJECTED ANNUAL GROUND VEHICLE REQUIREMENTS
PROPOSED ACTION

	Average Number of Vehicles										
Type of Vehicle	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sedans	2	2	2	2	2	2	2	2	2	2	2
Buses	10	10	10	10	11	11	11	10	10	10	10
Ambulances	4	4	4	4	4	4	4	4	4	4	4
Light Trucks	232	238	242	243	264	264	257	234	234	232	232
Medium Trucks	37	38	39	39	42	42	41	37	37	37	37
Heavy Trucks	17	17	18	18	19	19	19	17	17	17	17
Total Vehicles	302	309	315	316	342	342	334	304	304	302	302
Increase over 1988		7	13	14	40	40	32	2	2	0	0

Table 4.11-4
PROJECTED ANNUAL GROUND OPERATIONS
PROPOSED ACTION

	Miles of Operation (000s)										
Type of Vehicle	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sedans	7	7	7	7	8	8	8	7	7	7	7
Buses	78	80	81	82	89	89	86	79	79	78	78
Ambulances	5	5	5	5	6	6	6	5	5	5	5
Light Trucks	1,245	1,278	1,297	1,306	1,419	1,419	1,381	1,254	1,254	1,254	1,254
Medium Trucks	104	107	108	109	118	118	115	105	105	104	104
Heavy Trucks	25	26	26	26	28	28	28	25	25	25	25
Total Vehicles	1,464	1,503	1,524	1,535	1,668	1,668	1,624	1,475	1,475	1,464	1,464
Increase over 1988		39	60	71	204	204	160	11	11	0	0

Level of Service A, which is the highest quality of service. It is a condition of free flow in which there is little or no restriction on speed or maneuverability (Hamburger, 1982). Anticipated volumes would not lower the quality of service.

The increase in traffic would also not have a significant impact on the pavement life of the roadways. Pavement life depends on the volume of truck traffic. With the few trucks that are required and used, the increase under the Proposed Action is considered to be negligible over the 10-year period. Contractors whose construction traffic damages roadway pavement are required to repair the pavement. This practice would continue for future construction contracts, which are part of the Proposed Action.

The increase in vehicles would result in additional exhaust emissions and noise. The effect of this is discussed in Section 4.4, Air Quality and Noise.

As is also shown in Table 4.11-3, the maximum number of vehicles required as a result of the Proposed Action would be 40 in 1992 and 1993. This would result in an increase in operations of 204,000 miles for these years, as shown in Table 4.11-4. If the share of vehicles assigned to Kwajalein remains as it is, 33 additional vehicles would be added and would result in an additional 168,000 miles of operation. This is an increase of approximately 14 percent from existing conditions and does not represent a significant impact.

Bicycle and pedestrian traffic would also increase in proportion to the population, but this would have no significant impact.

Roi-Namur. The remainder of the increase in vehicles shown in Table 4.11-3 (i.e., the portion not assigned to Kwajalein) was assumed to be assigned to Roi-Namur. This would result in an increase of seven vehicles, operating an additional 36,000 miles a year. As with Kwajalein, this would not result in a significant impact. Volumes would not increase enough to reach road capacity and the increase in vehicles and operations would be less than 25 percent.

Other Islands. The existing vehicles and roadways on all the other islands are not anticipated to change as a result of the Proposed Action. Some additional vehicles may be required temporarily on an individual island to assist in the construction operations or with a mission (as is the case with Meck Island). These additional vehicles would have a negligible effect.

4.11.2.3 Change of Duration Alternative

The Change of Duration Alternative would have essentially the same program elements as the Proposed Action, but spread over a longer period of time. Some of the negligible impacts of the Proposed Action would be further eased by this alternative. As shown in Tables 4.11-5 and 4.11-6, the greatest increase in vehicles and operations would be in 1996 and 1997, but a total of only 21 additional vehicles would be required. This would result in an increase of only 18 vehicles and 83,000 miles on Kwajalein. Therefore, there are no significant impacts with the Change of Duration Alternative.

Table 4.11-5
PROJECTED ANNUAL GROUND VEHICLE REQUIREMENTS
CHANGE OF DURATION ALTERNATIVE

	Average Number of Vehicles										
Type of Vehicle	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sedans	2	2	2	2	2	2	2	2	2	2	2
Buses	10	10	10	10	10	10	10	10	11	11	11
Ambulances	4	4	4	4	4	4	4	4	4	4	4
Light Trucks	232	238	242	242	242	242	243	241	248	248	247
Medium Trucks	37	38	39	39	39	39	39	38	40	40	39
Heavy Trucks	17	17	18	18	18	18	18	18	18	18	18
Total Vehicles	302	309	315	315	315	315	316	313	323	323	321
Increase over 1988		7	13	13	13	13	14	11	21	21	19

4.11.2.4 Mitigation

Because no significant impacts have been identified, no mitigation is required.

Table 4.11-6
PROJECTION OF ANNUAL GROUND OPERATIONS
CHANGE OF DURATION ALTERNATIVE

Type of Vehicle	Miles of Operation (000s) 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sedans	7	7	7	7	7	7	7	7	8	8	7
Buses	78	80	81	81	81	81	82	81	83	83	83
Ambulances	5	5	5	5	5	5	5	5	5	5	5
Light Trucks	1,245	1,278	1,297	1,299	1,298	1,298	1,304	1,295	1,332	1,332	1,323
Medium Trucks	104	107	108	109	108	108	109	108	111	111	111
Heavy Trucks	25	26	26	26	26	26	26	26	27	27	27
Total Vehicles	1,464	1,503	1,524	1,527	1,525	1,525	1,533	1,522	1,566	1,566	1,556
Increase over 1988		39	60	63	61	61	69	58	102	102	92

4.11.2.5 Irreversible or Irretrievable Commitment of Resources

The only resources committed that could be considered irretrievable would be in fossil fuels consumed as a result of the Proposed Action or the Change of Duration Alternative. This is addressed in Subsection 4.12.5, Energy, and is considered to be insignificant.

4.11.3 MARINE TRANSPORTATION

Potential Areas of Concern

The alternatives potentially affect the number of ferry trips to other islands, the number of barge trips carrying cargo, and the facilities required to support the marine vessels.

Levels of Significance

- No or Negligible Impact. There would be no increase in the inventory of vessels or the operations of vessels.
- Insignificant Impact. The inventory of vessels or the operations of vessels would increase up to 25 percent above existing usage.
- Significant Impact. Impacts are defined as significant in this section if there was an increase in the inventory of vessels or the operations of the vessels by more than 25 percent over existing conditions.

4.11.3.1 No-Action Alternative

Under the No-Action Alternative, marine transportation would continue as it is now. The fleet of vessels is currently

operating well below capacity, with additional trips available if necessary.

4.11.3.2 Proposed Action

Atoll-wide Impacts. The Proposed Action would increase the number of trips required, but would not require an increase in the number of vessels. Table 4.11-7 summarizes the increase in miles of operation anticipated for the Proposed Action. The projected 942-mile increase per month in the peak years of 1992 and 1993, reflects a 14 percent increase in operations, which is not significant. An indirect effect of the Proposed Action would be increased air emissions, (discussed in Section 4.4, Air Quality and Noise).

Table 4.11-7
PROJECTED MONTHLY MARINE OPERATIONS
PROPOSED ACTION

	Miles of Operation										
Vessel	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Catamaran Ferry	1,902	1,953	1,982	1,995	2,167	2,167	2,109	1,915	1,915	1,902	1,902
Landing Craft, Materiel	4,642	4,766	4,836	4,870	5,289	5,289	5,148	4,674	4,674	4,642	4,642
Personnel Boat	216	222	225	227	246	246	240	217	217	216	216
Total	6,760	6,941	7,043	7,092	7,702	7,702	7,497	6,806	6,806	6,760	6,760
Increase over 1988		181	283	332	942	942	737	46	46	0	0

The Proposed Action would not require additional construction to accommodate the increase in operations. One transportation project is being constructed as part of the Proposed Action. The harbor at Meck Island is being improved by refurbishing the existing pier and concrete ramp. In addition, a small breakwater is being constructed to provide more protection for the vessels. Because the pier and ramp construction are being done to improve existing structures, no adverse impact on marine transportation results.

4.11.3.3 Change of Duration Alternative

Atoll-wide Impacts. The Change of Duration Alternative would have essentially the same program elements as the Proposed Action, but they would be spread over a longer period of time. Some of the negligible impacts of the Proposed Action would be lessened by this alternative. The operations oi the marine vessels, as shown in Table 4.11-8, would not be as great or as immediate as for the Proposed Action. The increase in operations of 470 miles per month in 1996 and 1997 represents only a 7 percent increase and, as a result, there would be no significant impacts from the Change of Duration Alternative.

Table 4.11-8
PROJECTED MONTHLY MARINE OPERATIONS
CHANGE OF DURATION ALTERNATIVE

	Miles of Operation										
Vessel	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Catamaran Ferry	1,902	1,953	1,982	1,985	1,984	1,983	1,992	1,978	2,034	2,034	2,021
Landing Craft, Materiel	4,642	4,766	4,836	4,844	4,841	4,839	4,862	4,827	4,965	4,965	4,933
Personnel Boat	216	222	225	225	225	225	226	225	231	231	230
Total	6,760	6,941	7,043	7,054	7,050	7,047	7,080	7,030	7,230	7,230	7,184
Increase over 1988		181	283	294	290	287	320	270	470	470	424

4.11.3.4 Mitigation

Because no significant impacts have been identified, no mitigation is required.

4.11.3.5 Irreversible or Irretrievable Commitment of Resources

The only resources committed as a result of the Proposed Action or Change of Duration Alternative that could be considered irretrievable would be the fossil fuels consumed. This is considered to be insignificant.

4.12 UTILITIES

4.12.1 WATER SUPPLY

Potential Areas of Concern

USAKA's water supply has the potential to be affected by changes in demand that strain the capacity of the system, possibly leading to water quality or quantity problems.

Levels of Significance

The environmental significance of impacts to the water supply facilities is measured in terms of effects on human health and safety associated with the availability and use of freshwater, and in its compliance with the provisions of the Safe Drinking Water Act (SDWA). Primary quantitative criteria for evaluation include: turbidity (as reported in turbidity units), pH, bacteriological quality, and maximum contaminant levels for various inorganic and organic compounds as regulated under the requirements of the SDWA.

The impact of increased demand is measured by the ability of the water supply system to provide a supply of water of suitable quality and quantity for consumption and use by the system users. The following levels of significance are defined for use in evaluating the Proposed Action:

- No or Negligible Impact. Baseline water supply would allow for the continued use of water within the capacity of the existing systems (groundwater and catchments) without development of additional source of supply. Supply water meets or exceeds requirements of SDWA.

- Insignificant Impact. Program-related impacts to the source of supply would be small relative to baseline water, but some minor shortfalls in capacity would occur unless water conservation measures are implemented. Occasional minor water quality problems.

- Significant Impact. Substantial supply impacts and shortfalls in supply would exist, particularly during abnormally dry or drought conditions. Does not meet requirements of SWDA.

4.12.1.1 No-Action Alternative

See Chapter 3, Subsection 3.12.1, for a description of existing water supply conditions. Freshwater turbidity from the existing Kwajalein filtration units has exceeded the maximum allowable requirements (0.5 turbidity units [TU]) of the SDWA much of the time. Other parameters appear to be within limits (Drinking Water Surveillance Program, 1988).

4.12.1.2 Proposed Action

The Proposed Action would increase the overall requirements for potable water. The increase in the nonindigenous population is expected to peak at 403 in the period from 1993 to 1994, about a 15 percent increase over the nonindigenous population of late 1988. For purposes of this discussion, the following distribution of the additional population is assumed:

- Kwajalein 320
- Roi-Namur 40
- Meck 43

Kwajalein. Impacts resulting from the Proposed Action would increase the potable water usage by about 35,000 gpd. The demand for potable water in the period from 1993 to 1994 would rise to a maximum of about 315,000 gpd from the existing 280,000 gpd. The addition of the proposed 150,000-gpd desalination plant would ease the production requirements

from the existing facilities and provide a more reliable supply of freshwater, especially during below normal rainfall periods. The combined capability of the existing system would be about 580,000 gpd during normal rainfall conditions and 380,000 gpd during drought conditions similar to those experienced in 1984. Even with the additional capacity, some curtailment of water use might be needed during an extreme drought condition during the peak population period.

An FY90 project to install a 150,000-gpd desalination plant has been identified to provide additional freshwater for Kwajalein. The plant would use waste heat from the new power plant (currently under construction) to produce desalted water. The plant is required to provide additional supply to overcome shortfalls during the dry season. The new plant would provide additional flexibility in the operation of the current freshwater facilities.

Roi-Namur. Impacts associated with the Proposed Action would increase the demand for potable water by about 4,300 gpd, bringing total usage to about 40,000 gpd. The existing catchment system produces 20,000 to 28,000 gpd and the lens wells have a combined pumping capacity of 270 gpm, or 390,000 gpd. No information regarding allowable sustained yield from the groundwater lens is currently available; however, the yield would not be expected to be any greater than that for Kwajalein. If the wells are pumped only to the extent needed to make up the shortfall of the catchments, about 20,000 gpd maximum would be required. This would amount to only 7.5 million gallons annually if pumped at 20,000 gpd continuously. This is about 15 percent of the allowable sustained yield for Kwajalein. The water supply should be adequate for the Proposed Action.

Meck. Impacts associated with the Proposed Action would result in the requirement of an additional 4,600 gpd to meet the needs of the personnel during the peak employment period from 1993 to 1994. The existing source is limited to rainwater captured in the catchment. If abnormally dry or drought conditions coincide with the peak population, it might be necessary to transport water from Kwajalein if the needs cannot be met locally.

Other Islands. Impacts to the remaining islands are expected to be minimal. Personnel going to islands without developed potable water supplies would continue to carry water with them.

4.12.1.3 Change of Duration Alternative

Atoll-wide impacts resulting from the Change of Duration Alternative would also increase the overall requirement for potable water, although the increment of increase would be

smaller than for the Proposed Action. The temporary non-indigenous population is expected to peak at 137 in 1995, or an increase of about 5 percent over the population at the end of 1988. The assumed distribution of the population follows:

- Kwajalein 110
- Roi-Namur 13
- Meck 14

Kwajalein. Impacts resulting from the Change of Duration Alternative would increase water usage by only 12,000 gpd. The demand would increase to about 292,000 gpd from the existing 280,000 gpd. Existing facilities would be able to meet the demand during normal conditions. Drought conditions could result in the need to restrict water use for some purposes under this alternative until the proposed 150,000-gpd desalination plant is constructed.

Roi-Namur and Meck. Impacts stemming from the increased population would require about 1,400 and 1,500 gpd, respectively, for each system. Existing facilities should meet these requirements.

4.12.1.4 Mitigation

Proposed Action

Mitigation of shortfalls of supply on Kwajalein during abnormally dry years or drought conditions could be met by water conservation measures and/or addition of the proposed 150,000-gpd desalination plant.

Change of Duration Alternative

Mitigation of this alternative would be the same as for the Proposed Action.

4.12.1.5 Irreversible or Irretrievable Commitment of Resources

The water supply is a renewable resource; therefore, no resources would be irreversibly or irretrievably committed by any of the alternatives.

4.12.2 WASTEWATER COLLECTION, TREATMENT, AND DISPOSAL

Potential Areas of Concern

Increases in work force and population could put demands on the wastewater system that could affect the quantity and quality of effluents and ultimately the quality of receiving waters.

Levels of Significance

The environmental significance of wastewater collection, treatment, and disposal is measured by the effectiveness of treatment as evidenced by the quality of the effluent and its effect on receiving water. The standards are set under the Clean Water Act in accordance with water quality regulations. The quantitative criteria evaluate parameters such as bacterial coliform levels, biological oxygen demand (BOD), suspended solids, pH, and discharge flows.

The impact of increased plant loading is measured by the ability of the facilities to collect and treat sewage and continue to discharge effluent within the established discharge permit parameters.

The following levels of significance are defined for use in evaluating the action alternatives:

- No or Negligible Impact. Wastewater collection, treatment, and disposal would continue without degradation of plant effluent quality. Inflow would not exceed design capacity of the plant.

- Insignificant Impact. Impacts to wastewater collection, treatment, and disposal would be small relative to the baseline condition, but some increase in plant discharge constituents, not exceeding discharge requirements, would occur.

- Significant Impact. Substantial impacts and degradation of effluent quality would occur. Maximum effluent discharge requirements would be exceeded.

4.12.2.1 No-Action Alternative

See Subsection 3.12.2 for a description of existing conditions. The Kwajalein wastewater treatment plant is reaching the design hydraulic value with current flows. Effluent quality is better than that required under the current operating permit. The plant is currently operating at about 70 percent of its organic loading capacity. USAKA is required to monitor effluent water quality from wastewater outfalls (NPDES point sources).

4.12.2.2 Proposed Action

The Proposed Action would increase the overall requirements for collection, treatment, and disposal of wastewater. See Subsection 4.12.1 for a discussion of the distribution of the peak increase in nonindigenous population predicted for 1993 to 1994.

Kwajalein

The Proposed Action would increase sewage flows received at the wastewater treatment plant to approximately 520,000 gpd, or an increase of 55,000 gpd. This increase in flow might result in the plant (which is already at its design hydraulic load) periodically discharging excessive suspended solids. Organic loading resulting from the Proposed Action would remain within the plant design capacity. Plant operations might become unstable, with periodic suspended solids loss through the effluent, and the other primary measurement criteria, such as biological oxygen demand, might not be met.

Roi-Namur

The Proposed Action would increase discharge to the wastewater systems by approximately 7,000 gpd, most of which would be discharged through the existing system and ocean outfall. The additional discharge identified above, together with the baseline flow of 44,000 gpd through the outfall, would result in an average flow of 51,000 gpd during the peak period of 1993 to 1994. The proposed 70,000-gpd package wastewater treatment plant would serve the west end of Roi-Namur Island. This plant would eliminate the discharge of untreated sewage through the existing outfall. The project is programmed to provide a plant with secondary treatment processes.

As of April 1989, the project was at the 35 percent complete stage (conceptual design) and under review to determine the actual processes to be included in the final design.

Meck

The Proposed Action would result in an additional 7,700 gpd wastewater flow projected for the peak population during the period from 1993 to 1994. The septic tank/leach field system should adequately serve the additional discharge to the system. Groundwater would receive nutrients associated with the wastewater. Groundwater is not used for drinking water on Meck; therefore, the increased nutrients in the groundwater should not be an impact.

4.12.2.3 Change of Duration Alternative

Impacts resulting from the Change of Duration Alternative would increase the discharge of wastewater to the collection, treatment, and discharge systems relative to the baseline (see Subsection 4.12.1 for discussion of the distribution of the peak population during 1995 for this alternative).

Kwajalein

Impacts resulting from the change of duration alternative would increase the discharge of wastewater by about 20,000 gpd. The wastewater flow through the treatment plant would increase from 465,000 gpd to 485,000 gpd. This additional flow would result in the plant flow being slightly greater than design hydraulic capacity. An increase of effluent suspended solids exceeding discharge standards could occur.

Roi-Namur and Meck

Impacts caused by the increase in population would require about 2,300 and 2,500 gpd, respectively, additional wastewater collection, treatment, and disposal capacity. Proposed and existing facilities should adequately meet these requirements.

4.12.2.4 Mitigation

Proposed Action

Impacts of the Proposed Action for Kwajalein could be mitigated by water conservation and/or by construction of an additional clarifier to prevent biological solids wash-through and consequent reduction of plant efficiency. If field testing of reactor capability shows reactor overloading with increased loadings as a result of population increases, an additional biological reactor will be required.

Change of Duration Alternative

Mitigation of this alternative would be the same as that for the Proposed Action.

4.12.2.5 Irreversible or Irretrievable Commitment of Resources

Neither of the action alternatives involves irreversible or irretrievable commitments of resources related to wastewater systems, except for the resources used for the construction of the package treatment plant at Roi-Namur.

4.12.3 SOLID WASTE

Potential Areas of Concern

The action alternatives may affect the quality of human health and the environment. Specific media include groundwater, surface water, soil, and air.

Levels of Significance

- No or Negligible Impact. No increase in the probability of adverse impacts to health or to the environment.

- Insignificant Impact. An increase in the probability of adverse impacts to health or the environment, but not to the extent that the action by itself or as a cumulative impact with existing conditions violates regulatory standards.

- Significant Impact. An action that poses a reasonable probability of adverse effects on health or the environment, or that by itself or as a cumulative impact with existing conditions violates regulatory standards.

4.12.3.1 No-Action Alternative

Subsection 3.12.3 describes existing solid waste practices in detail.

Municipal Solid Waste

Adequate collection and disposal capacities exist on Kwajalein and Roi-Namur for the municipal solid waste currently generated. Collection methods are simple. Disposal is accomplished by open dumping, open burning, and septage trenching and burial.

Construction Solid Waste

Construction debris is stored in the open dumps on Kwajalein and Roi-Namur, and in discrete piles on Meck and Illeginni. Asbestos is stored in Building 1045 on Kwajalein.

Operations Solid Waste

Scrap materials are stored in piles on all of the islands except Ennugarret. Spent lead-acid batteries are disposed of in the open dumps on Kwajalein and Roi-Namur. Collected waste oil is disposed of in unlined, bermed pits on Kwajalein and Roi-Namur, where the oil is periodically open-burned.

4.12.3.2 Proposed Action

Municipal Waste

The Proposed Action would increase the volume of municipal waste generated, collected, and disposed of on Kwajalein and Roi-Namur as a result of the projected increase in population. This increase in waste would exacerbate the short-

comings in existing waste handling practices identified in Chapter 3, Subsection 3.12.3 (including open dumping, open burning, and septage trenching and burial). There would be increased air emissions from open burning, increased potential for groundwater and marine water contamination from landfilling and open dumping, and increased potential for disease vectors from septage trenching and burial.

The cumulative impact of the existing inadequate practices and the additional incremental impact of municipal solid waste resulting from the Proposed Action would meet the definition of significant impacts defined above.

Construction Solid Waste

The Proposed Action would increase the volume of construction solid waste generated on Kwajalein, Roi-Namur, Meck, and Omelek. The increased volume of construction could increase the potential for uncovering and for the inadequate handling of additional asbestos-containing materials. The cumulative impact of the existing inadequate handling practices and the additional incremental impact of construction solid waste resulting from the Proposed Action would meet the definition of significant impacts defined above.

Operations Solid Waste

The increase in population and operations resulting from the Proposed Action would generate additional scrap materials on Kwajalein, Roi-Namur, Meck, and Omelek islands; and spent batteries on Kwajalein, Roi-Namur, Meck, and Ennylabegan Islands. The cumulative impact of the existing inadequate practices and the increment of operations solid waste that would result from the Proposed Action would meet the definition of significant impacts defined above.

4.12.3.3 Change of Duration Alternative

The effects of the Change of Duration Alternative on solid waste volumes and environmental effects would be the same as for the Proposed Action. Only the timing of impacts would differ because of the schedule changes of the Change of Duration Alternative.

4.12.3.4 Mitigation

Mitigation measures would be the same for the Proposed Action and the Change of Duration Alternative.

Municipal Solid Waste

The identified adverse impacts of municipal solid waste practices could be mitigated by upgrading the design, construction, and operation of the existing open dump to

regulated sanitary landfill status, by installing and operating a regulated municipal waste incinerator.

Subtitle D of RCRA establishes the requirements for management of nonhazardous solid waste. These requirements, which are codified in 40CFR Part 257, are currently being amended to strengthen existing criteria. The current standards for solid waste land disposal facilities state that facilities shall not contaminate groundwater or surface water, but they recommend only procedures and designs to meet the requirements. For example, leachate detection and collection is recommended for this purpose. To comply with the 40CFR Part 257, the hydrogeological characteristics of the facility and surrounding land should be collected; the volume, physical, and chemical characteristics of the leachate should be determined; the existing quality of the groundwater should be assessed; and the construction and operation of the landfill should be modified as described in the federal guidelines.

Open burning is defined by 40CFR 257 as the combustion of solid waste without (1) control of combustion air to maintain adequate temperature for efficient combustion, (2) containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and (3) control of the emission of the combustion products. To comply with the regulations, a solid waste incinerator should be installed and operated in a manner that complies with applicable requirements pursuant to the Clean Air Act, as amended. The incinerator should consist of an enclosed device using controlled flame combustion, which thermally breaks down solid, liquid, or gaseous combustible solid wastes to an ash residue that contains little to no combustible materials. Handling, storage, transportation, disposal, or beneficial use of ash residue should comply with the regulations.

In accordance with 40CFR 257, land disposal of untreated sewage sludge and septic tank pumpings is not allowed. The existing Part 257 criteria were co-promulgated under the joint authority of RCRA and the Clean Water Act. In February 1987, Congress enacted provisions under the Clean Water Act that address sewage sludge. Once promulgated, these regulations will address the incineration, ocean disposal, and land application of sewage sludge. The currently proposed amendments to RCRA regulations address the co-disposal of sewage sludge and household wastes in municipal solid waste landfills.

Construction Solid Waste

New procedures for collecting construction solid waste on Meck and Omelek and transporting it to Kwajalein should be

established to comply with applicable regulations and standards. Handling practices for friable asbestos-containing materials on Kwajalein, Roi-Namur, Meck, and Omelek should be modified to comply with the Clean Air Act.

Operations Solid Waste

Spent Batteries. Procedures for disposing of spent batteries should be modified to comply with federal standards. Means to mitigate adverse impacts of spent battery disposal include reclamation and recycling programs as outlined in 40CFR 261.

Landfills. As previously discussed, the design, construction, and operation of the open dumps should be upgraded to regulated sanitary landfill status.

4.12.3.5 Irreversible or Irretrievable Commitment of Resources

Neither of the action alternatives involves the commitment of irreversible or irretrievable commitments of resources.

4.12.4 HAZARDOUS MATERIALS AND WASTE

Potential Areas of Concern

The action alternatives may affect the quality of human health and the environment. Specific media include groundwater, surface water, soil, and air.

Levels of Significance

- No or Negligible Impact. No increase in the probability of adverse impacts to health or to the environment.

- Insignificant Impact. An increase in the probability of adverse impacts to health or the environment, but not to the extent that the action by itself or as a cumulative impact with existing conditions does not comply with regulatory standards.

- Significant Impact. An action that poses a reasonable probability of adverse effects on health or the environment, or that by itself or as a cumulative impact with existing conditions does not comply with regulatory standards.

4.12.4.1 No-Action Alternative

Hazardous Materials

Explosives, solid rocket boosters, liquid propellants, and pesticides are properly stored at USAKA and current storage capacity is adequate. Storage practices for petroleum fuels and lubricants do not prevent releases to the environment as evidenced by recent observation of a hydrocarbon layer on the water table at Kwajalein.

Hazardous Waste

Solvent waste is currently mixed with waste oil, stored in unlined pits, and open-burned on Kwajalein; neutralized acids and bases are discharged to the sanitary sewer, taken to the landfill for disposal, or left to evaporate; and transformers and drained oil containing PCBs are stored in Building 1500 on Kwajalein. Portions of the floor of Building 1500 are contaminated with PCBs resulting from spills that occurred during handling of PCB equipment. These practices are not consistent with existing environmental standards. Building rehabilitation as part of the Proposed Action should have the effect of removing additional transformers (containing oils contaminated with PCBs) from service, or moving abandoned transformers from older buildings. Sandblasting residue collects on the shore of the lagoon of the two islands and at discrete areas inland on Kwajalein and Roi-Namur Islands.

With the hazardous and nonhazardous waste management practices currently employed at USAKA, the quantity of hazardous waste generated exceeds the small quantity generator limit. Therefore, the storage, treatment, and disposal facilities/operations at USAKA will comply with RCRA standards and the hazardous waste may require shipment to a licensed disposal facility on the U.S. mainland.

4.12.4.2 Proposed Action

Hazardous Materials

The Proposed Action would increase the consumption of fuel and other petroleum products due to the projected increase in the use of vehicles and heavy equipment. There would be an increased potential for groundwater and marine water contamination because of the increase in the quantities of petroleum products and solvents stored using the inadequate practices described above. The cumulative impact of the existing inadequate practices and the increment of hazardous materials caused by the Proposed Action would meet the definition of significant impacts defined above.

Hazardous Waste

Waste Oil and Solvent Wastes. The Proposed Action would increase the use of vehicles and heavy equipment during the proposed construction and operations activities, resulting in an increase in waste oil generation on Kwajalein, Roi-Namur, Meck, and Omelek. Additional solvent waste would be generated on Kwajalein, Meck, Omelek, and Roi-Namur in association with the increased number of launches. When disposed of using current inadequate disposal facilities (unlined bermed pits on Kwajalein and Roi-Namur), the increase in waste oil and solvent wastes has the potential to increase ground and water contamination.

Sandblasting. There would be more sandblasting residue from increased sandblasting activities on Kwajalein, Meck, Omelek, and Roi-Namur, potentially leading to an increase in contaminants from paint and metal constituents.

Spent Batteries. Additional spent lead-acid batteries would be generated by the increased transportation activity (see Section 4.11, Transportation). Spent lead-acid batteries are not reclaimed or recycled at USAKA; therefore, they are regulated as hazardous waste.

PCB Contamination. Building 1500 is proposed as the site of the GBR-X radar facility. The Proposed Action would require the removal of PCB transformers currently stored in Building 1500 while they await permanent disposal. The building would also require remediation of its current PCB contamination.

With the hazardous and nonhazardous waste management practices currently employed at USAKA, the quantity of hazardous waste that would be generated (including the quantity resulting from the action alternatives) exceeds the small quantity generator limit. The cumulative impact of the existing inadequate hazardous waste practices and the additional incremental impact of hazardous waste resulting from the Proposed Action would meet the definition of significant impacts defined above.

4.12.4.3 Change of Duration Alternative

The effects of the Change of Duration Alternative on hazardous materials and waste volumes, and the environmental effects would be the same as for the Proposed Action. Only the timing of impacts would differ as a result of the schedule changes for the Change of Duration Alternative.

4.12.4.4 Mitigation

Mitigation measures would be the same for the Proposed Action and the Change of Duration Alternative.

Hazardous Materials

The identified adverse impacts of current petroleum products and solvents storage could be mitigated by upgrading the design and construction of the berm walls and floor in aboveground storage areas, by complying with the technical requirements for underground fuel storage, and by upgrading the design and construction of hazardous material storage areas. Pertinent design and operations considerations would include containment requirements, compatibility of hazardous materials with construction materials, and recordkeeping and inspection requirements.

Hazardous Wastes

Waste Oil Disposal. The identified adverse impacts of current waste oil disposal practices could be mitigated through the replacement of the current unlined burn pits with an industrial furnace or boiler to burn the oil for energy recovery. The burn pits should be closed as hazardous waste surface impoundments because the oil is not handled as a recyclable material, and the waste oil can be classified as a hazardous waste.

Solvent Waste. Disposal practices for solvent wastes should comply with hazardous waste management regulations under Subtitle C of RCRA and codified in 40CFR 264. Solvent waste should be segregated from waste oil, and improved tracking or recordkeeping should be initiated. Reclamation or recycling is an option for handling solvent waste. Another option consists of mixing solvents with waste oil and burning the resulting hazardous waste fuel in an industrial furnace or boiler in accordance with the codified regulations (40CFR 266) under RCRA. Collection, storage, and inter-island transportation procedures that comply with the hazardous waste management regulations should be implemented.

Sandblasting. After testing to determine contaminant levels, sandblasting should be conducted in a dedicated area that is lined with an impervious material, that provides containment, and that prevents dispersion of the materials into the air.

Spent Batteries. Management practices of acids and bases from spent batteries should be modified to include neutralization in an elementary neutralization unit constructed in a manner that prevents the release of hazardous waste into the environment during treatment. Open dumping of the acids, bases, or neutralized solutions should not be employed; and, depending on the waste-generating activity, discharge to the sanitary sewer might have to be eliminated.

PCB Contamination. In addition to the storage and disposal of the transformers and oils containing PCBs, remediation of contamination in Building 1500 will be in accordance with regulations under the Toxic Substances Control Act. Regulations promulgated under the Toxic Substances Control Act allow disposal of limited categories of PCB materials in a municipal solid waste landfill. Such materials include drained PCB-contaminated electrical equipment, PCB articles that previously contained 50 to 499 ppm of PCBs and that have been drained of free-flowing liquids, and small capacitors that contain less than 3 pounds of PCB dielectric. Disposal of all other PCB material at USAKA is not acceptable; therefore, disposal of much of the PCB material should be by a licensed contractor on the U.S. mainland.

4.12.4.5 Irreversible or Irretrievable Commitment of Resources

Neither of the action alternatives involves irreversible or irretrievable commitments of resources.

4.12.5 ENERGY

Potential Areas of Concern

The action alternatives may affect electrical peak load, electrical energy requirements (kilowatt hours), power plant generation capacity (kilowatts), electrical distribution feeder capacity, and fuel consumption for power generation and transportation. Other areas that are indirectly affected are air quality and noise around the power plants. Thermal discharge of seawater used for indirect engine cooling is a factor around the three Kwajalein power plants and the Roi-Namur plant. Impacts of noise, air quality, thermal discharges, and increased production of waste lubricating oils from the power plants are addressed in other sections.

Levels of Significance

Three levels of significance have been identified:

- No or Negligible Impact. No increase in plant generation capacity required. No change in electrical distribution system required. No or negligible increase (less than 10 percent) in peak load (kilowatts), power production (kilowatt hours), or fuel consumption.

- Insignificant Impact. Minimal or no change in plant generation capacity required. Minimal change in electrical distribution system required. Minimal to moderate increase (10 to 20 percent) in

peak load (kilowatts), power production (kilowatt hours) and fuel consumption.

- Significant Impact. Increase in power plant generation capacity required. Changes to electrical distribution system such as the addition of new feeders required. Substantial increase (more than 20 percent) in peak load (kilowatts), power production (kilowatt hours), and fuel consumption. Additional capacity for fuel storage may be required.

4.12.5.1 No-Action Alternative

Under the No-Action Alternative, energy consumption for USAKA is assumed to increase approximately 10 percent over the next 10 years. This assumption is based on observation of historical trends and the assumption that electrical demand will increase slowly as a result of greater use of computerized equipment, more air-conditioning of storage areas and other facilities, and miscellaneous other increases in electrical demand to support ongoing range activities. Historical (1988) and projected (1998) fuel consumption (DFM) for power generation is shown in Table 4.12-1 for the No-Action Alternative.

4.12.5.2 Proposed Action

Energy consumption for the Kwajalein Atoll would substantially increase under this alternative. Increased quantities of fuels would be consumed for electrical power generation, aircraft, and automotive and small boat use. The increase in fuel use for transportation would be negligible compared with the increase in fuel use for electrical power generation. Construction impacts of the Proposed Action would be negligible. Power consumption from the Proposed Action would have a significant impact on power generation on Kwajalein. The SDI launch facilities on Meck and Omelek would have a significant impact on energy consumption and facilities for the individual islands, but would have negligible to low impact for the atoll. Projected 1998 fuel consumption (DFM) for power generation for the Proposed Action is shown in Table 4.12-1.

Variations in population (up to approximately 300 to 500 persons) would have negligible to low impacts on electrical peak load and energy consumption. The square footage of building facilities with associated support equipment (air-conditioner, lighting, etc.) would have a more direct impact on electrical demand and energy requirements than population. Houseing facilities at USAKA are air-conditioned even when empty in an effort to reduce damage caused by humidity.

Table 4.12-1
POWER PLANT FUEL CONSUMPTION (DFM)

Island/Plant	Plant[a] Capacity (kW)	1988[a] Fuel Consumption (gal)	1998 Fuel Consumption No-Action (gal)[b]	1998 Fuel Consumption Proposed Action (gal)[c]	% of Total Consumption Proposed Action 1998[d]
Kwajalein					
Plant 1	13,500	4,450,000	790,000	1,300,000	10
Plant 1A	12,000	-0-	3,960,000	6,650,000	50
Plant 2	5,280	350,000	530,000	895,000	7
Roi-Namur	12,000	2,930,000	3,220,000	3,220,000	24
Meck	2,825	245,000	270,000	640,000	5
Ennylabegan	800	180,000	198,000	198,000	1
Illeginni	390	90,000	99,000	99,000	0.5
Eniwetak	180	30,000	33,000	33,000	0.5
Omelek	390	30,000	33,000	99,000	0.5
Gellinam	380	90,000	99,000	99,000	0.5
Gagan	260	60,000	66,000	66,000	0.5
Legan	260	60,000	66,000	66,000	0.5
Totals		8,515,000	9,364,000	13,365,000	100

[a] Source: Pan Am World Services, Inc., June 1988. Telephone communication from Bob Walker, Utilities Manager, Pan Am World Services, April 1988. Future capacity of Omelek is assumed.

[b] Projected 1998 energy consumption for the No-Action Alternative is assumed to be 10 percent above 1988 levels.

[c] Projected 1998 Proposed Action and Change of Duration Alternative fuel consumption (DFM) for power generation are nearly identical for all islands.

[d] Percent of total fuel consumption (DFM) for Kwajalein Atoll. Proposed Action and Change of Duration Alternative are identical in 1998.

Kwajalein

The projected electrical loads for construction for the Proposed Action on Kwajalein Island are shown in Table 4.12-2.

The projected peak load and fuel consumption for power generation for Kwajalein Island are shown in Figure 4.12-1. Historical information is also shown in this figure.

A 12,000-kW Power Plant 1A is currently being built on Kwajalein Island. Its construction will ensure adequate capacity to meet current needs and the power requirements of the Proposed Action.

Table 4.12-2
ELECTRICAL LOADS ASSOCIATED WITH PROPOSED ACTION CONSTRUCTION PROJECTS
KWAJALEIN ISLAND

Project Description	Completion Date	Average Load (kW)	Peak Load (kW)
Unaccompanied Personnel Housing	1990	615	880
Family Housing	1991	550	780
Desalination Plant	1991	90	60
GBR-X Radar Facility	1993	2,600	4,100

The Kwajalein fuel farm currently has storage capacity of 6,468,000 gallons of DFM. This amount of DFM will support the atoll for approximately 9 months at current consumption rates. With increased energy consumption required for the Proposed Action, the same amount of fuel would support the atoll for approximately 6 months.

Roi-Namur

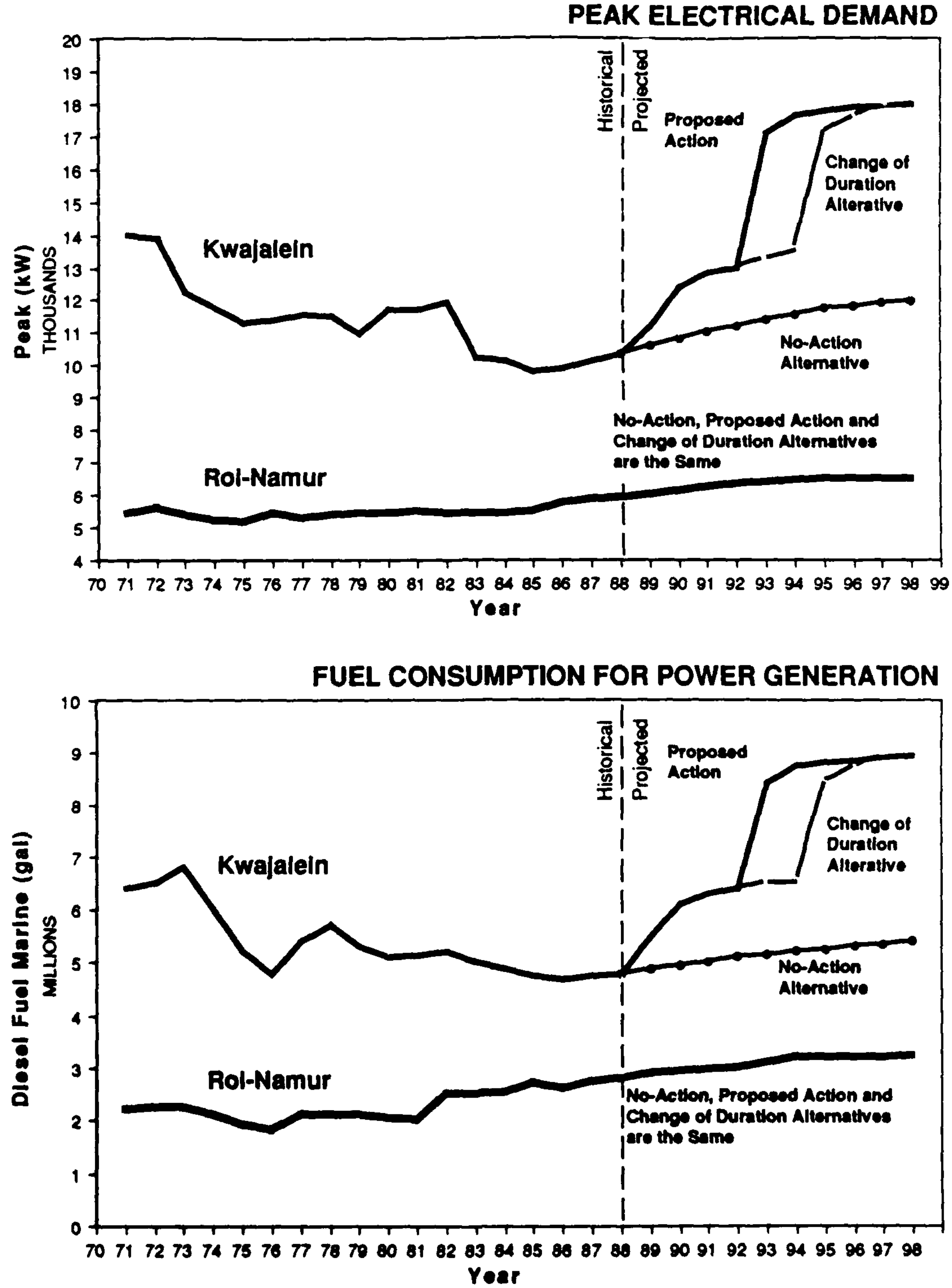
The projected electrical loads for proposed construction projects on Roi-Namur are shown in Table 4.12-3. These projects would have a negligible impact on energy for Roi-Namur.

Table 4.12-3
ELECTRICAL LOADS FOR PROPOSED ACTION CONSTRUCTION
ROI-NAMUR

Project Description	Completion Date	Average Load (kW)	Peak Load (kW)
Packaged Sewage Treatment Plant	1991	35	50
Document Control Facility	1991	20	30

Meck

The existing power plant capacity would be insufficient to support the proposed SDI launch activities. The three existing 350-kW engine generators are being replaced during 1989 with five 565-kW units. Fuel oil consumption will



SOURCE: Based on USAKA Monthly Statistics - Electrical (Pan Am World Service, Inc.)

U.S. ARMY KWAJALEIN ATOLL
ENVIRONMENTAL IMPACT STATEMENT
U.S. Army Corps of Engineers

EFFECTS ON ENERGY CONSUMPTION
KWAJALEIN & ROI-NAMUR

Figure 4.12-1

increase from approximately 240,000 to 640,000 gallons per year.

Omelek

The existing power plant capacity would be expanded as a result of increased launch activity. The plant capacity is assumed to increase from 120 kW to 390 kW. The fuel oil consumption would increase from approximately 30,000 to 90,000 gallons per year.

Other USAKA Islands

Increases in energy consumption for the other islands as a result of the Proposed Action would be negligible.

4.12.5.3 Change of Duration Alternative

The Change of Duration Alternative would have the same program elements as the Proposed Action, but would be spread over a longer period of time. Under this alternative the GBR-X would be delayed 2 years.

Projected peak electrical demand and fuel consumption for Kwajalein and Roi-Namur Islands for the change of Duration Alternative are shown in Figure 4.12-1.

4.12.5.4 Mitigation

The Corps of Engineers has directed that all new construction shall consider energy conservation measures. These measures include building color, siting and window orientation to reduce solar gain, using double-paned windows with reflective film, adding insulation, and recovering heat from air-conditioners to preheat water for residential hot water use. Implementation of these conservation standards in new construction will help lower the energy consumption impacts of the action alternatives. These actions, along with Power Plant 1A and the five 565-kW units on Meck, will provide the required energy.

4.12.5.5 Irreversible or Irretrievable Commitment of Resources

The additional consumption of fuel oil resulting from the action alternatives represents an irreversible or irretrievable commitment of a nonrenewable resource.

4.13 AESTHETICS

Potential Areas of Concern

Impacts on visual resources were evaluated based on the potential effect on the visual character of landscapes and on the number of viewers potentially affected.

Levels of Significance

The following definitions were used to assess significance:

- No or Negligible Impact. No change to the character of the existing landscape.
- Insignificant Impact. A change to the character of the visual landscape that would not be perceived by the resident population.
- Significant Impact. A change to the character of the visual landscape that would be perceived by the resident population.

4.13.1 No-Action Alternative

The visual resources of the affected environment are described in Chapter 3, Section 3.13.

4.13.2 Proposed Action

The effects on visual resources will be insignificant, as described below.

Kwajalein and Roi-Namur

All of the proposed construction activities will take place in areas that are already substantially altered by range activities. The visual changes will be insignificant because new construction will not introduce any new visual elements, and will not alter the visual character of the landscape.

Meck

Construction will occur on Meck to support the HEDI, ERIS, and SBI programs and to complement the existing range assets. The new construction will not alter the visual character of the landscape. The visual changes that do occur will be seen only by the security guards (two, on 24-hour shifts), construction crews on the island during the construction phase, and operations personnel who will commute from Kwajalein at the time of missions. The impact of any visual effects will be insignificant.

Omelek

Construction associated with the GSTS launch program requires new and expanded buildings and other facilities on Omelek. It will marginally change the visual landscape of Omelek, increasing the built-up character of the island. Any visual changes on Omelek will have an insignificant impact since Omelek has no residents and the changes to the visual character of the island will be perceived only by the security guards (two, on 24-hour shifts), construction crews on the island during the construction phase, and operations personnel who will commute from Kwajalein at the time of GSTS missions.

4.13.3 Change of Duration Alternative

The impacts for the Change of Duration Alternative will be the same as those for the Proposed Action. In this case, the impacts for the Proposed Action are insignificant.

4.13.4 Mitigation

Because no significant impacts have been identified, no mitigation is required.

4.13.5 Irreversible or Irretrievable Commitment of Resources

The Proposed Action and the Change of Duration Alternative would not involve any irreversible or irretrievable commitments of visual or aesthetic resources.

4.14 RANGE SAFETY

Potential Areas of Concern

The areas of range safety that may be potentially affected by the Proposed Action and alternatives are injury or loss of life as a result of occupational accidents or exposure to toxic materials, and injury, loss of life, or property damage to the general public in the Marshall Islands or to aircraft or surface vessels.

Levels of Significance

The significance of range safety impacts is measured in terms of the direct effect on human health and property and compliance with applicable federal safety regulations. Limits for the exposure of construction and operations workers to toxic or hazardous materials are set at levels to prevent long-term detrimental effects. The impact of range safety programs associated with explosives handling, missile launches, and reentry of airborne payloads is measured by

the number of injuries and deaths of mission staff and the general public and the extent of property damage. The level of significance is defined as follows:

- No or Negligible Impact. The rate of mission-related accidents causing injury or loss of life would not increase in the general public. The rate of occupational accidents would not increase based on worker manhours. Full compliance is attained for occupational safety and health standards.

- Insignificant Impact. The rate of accidents in the workplace and the rate of noncompliance to occupational safety and health standards would exceed average values for military installations having missile operations.

- Significant Impact. The rate of mission-related accidents causing injury or loss of life or the rate of near-miss incidents involving populated land areas, aircraft, or ships would increase substantially.

4.14.1 GROUND SAFETY

4.14.1.1 No-Action Alternative

Safety procedures exist and are practiced at USAKA facilities with acceptable results (see Chapter 3, Section 3.14). Ongoing operations will not adversely affect public and occupational safety.

4.14.1.2 Proposed Action

Kwajalein Island

The Proposed Action would result in an increased number of hazardous operations and a potential for accidents at Kwajalein. Missile launch programs would require the transportation and storage of solid rocket motors, liquid propellants, explosives, industrial raw materials, and solvents. Most of these materials would be handled in an area of Kwajalein that is not near residential housing. No new types of materials would be handled, only greater quantities than current operations require.

The existing storage magazines have the capacity to store propellant and explosives for the proposed programs in accordance with USAKA explosives safety regulations. The proposed program does not require more than three sets of solid rocket motors at Kwajalein for concurrent missions. These motors are within current storage capacity limits and would remain on Kwajalein for only a brief period. The

transportation of hazardous materials by aircraft into Kwajalein and by barge to the other islands would be affected by increased activity, but not by new or more hazardous activities.

The proposed programs would have an approved systems safety hazard analysis before testing at USAKA. The analysis would include operations conducted on Kwajalein and the other islands involved. Proposed programs would also have approved ground safety plans that identify potential hazards and accident scenarios and contain general procedures for worker and publi· safety. Fire safety and security requirements would be defined in the ground safety plan for each program.

Programs would have written procedures for all hazardous operations. These procedures would require approval of the USAKA Safety Office and would be supervised by a government safety representative during execution.

Roi-Namur Island

The Proposed Action would increase the missile launch activity at Roi-Namur with the SBI target program. The same plans and procedures that are used to provide occupational and public safety would be used for new launch missions. There have been no serious injuries or deaths caused by launch activities in two decades of testing, which includes a period in the 1970s when launch operations were conducted much more frequently. The increase in activity resulting from the Proposed Action would not have a significant impact on safety during launch preparation.

The Proposed Action would not adversely affect Roi-Namur radar activity. An increase in mission-related radar tracking activity would occur, but the total time of radar operation would not be significantly increased.

Meck Island

The Proposed Action would reactivate idle facilities at Meck for the assembly and launch of missiles for the SBI, ERIS, and HEDI programs. Major rehabilitation activity at Meck consisting of the ERIS, HEDI, and SBI launch complexes and small craft berthing facility would employ a large construction workforce and would require demolition and heavy equipment operation. Current safety procedures, which comply with OSHA standards, would be in effect during proposed construction.

The Proposed Action involves the assembly and launch of approximately 17 interceptor missiles during the period from 1990 to 1996. The potential for accidents resulting from launch preparation operations would be mitigated using

existing explosives safety regulations and DOD directives, hazards analysis of launch programs, and detailed procedures for hazardous operations. These measures were employed in past launch operations at Meck. During the early 1970s, a more frequent missile test flight schedule and greater number of launch missions were completed without a serious injury or fatality to the island workforce. An accident during launch preparation activities would not affect neighboring islands or air and ocean traffic.

Omelek Island

The Proposed Action would consist of construction and operation of missile test flights to support the GSTS program. Construction would include enlargement of the two launch pads, a new missile assembly building, and rehabilitation of existing facilities. Current safety policies, which comply with OSHA standards, would be enforced to mitigate construction hazards.

Six launches of a single missile or pairs of missiles are proposed for the GSTS program. The mitigation of potential accidents during mission preparation activities would be addressed through the plans, procedures, and evaluations that are currently used for test flight missions at USAKA. Omelek is an existing site for meteorological and sounding rocket launches.

4.14.1.3 Change of Duration Alternative

Meck and Omelek Islands

The Change of Duration Alternative would reduce the amount of concurrent construction activity and the frequency of missions, but would have no significant effect on the amount of labor involved in construction and hazardous operations. This alternative would have no effect on the level of exposure of the workforce and general public to potential accidents and consequently would have little effect on safety performance.

4.14.1.4 Mitigation

No significant impacts are anticipated; therefore, no mitigation is required.

4.14.1.5 Irreversible or Irretrievable Commitment of Resources

No irreversible or irretrievable commitments of resources, or net or residual impacts would occur as a result of the Proposed Action. The islands affected by the proposed programs have an exceptionally good occupational and public safety history compared with the related aircraft industry.

4.14.2 FLIGHT SAFETY

4.14.2.1 No-Action Alternative

Flight safety procedures are currently practiced at USAKA facilities with exemplary results. Ongoing operations will not adversely affect public safety at USAKA or the other RMI islands.

4.14.2.2 Proposed Action

Kwajalein Island

The Proposed Action includes two programs, AOA and HALO/IRIS, which would increase the frequency of mission-related aircraft at Kwajalein. Both programs would use modified passenger aircraft to carry instrumentation around the perimeter of mission areas during certain reentry vehicle and missile flights. The potential hazards of these programs would be defined in flight safety plans and would mainly consist of the hazards associated with aircraft flight over populated areas. Any potential threat to public safety would be mitigated by procedures in the flight safety plan and established aircraft operating procedures.

Roi-Namur, Meck, and Omelek Islands

The Proposed Action would result in additional missile launches from Roi-Namur, Meck, and Omelek for the ERIS, HEDI, SBI, and GSTS programs. Each mission of these programs would have an approved flight safety plan that would define the areas affected by the mission, the caution and hazard areas, and the precautions required to protect inhabited islands. The Kwajalein Range Safety System would be in operation during these missions and the missiles tested in these programs would be equipped with flight termination systems to destroy off-course flights.

Other RMI Islands

A total of approximately 20 reentry vehicle missions per year are proposed. Many of these missions are part of ongoing operational testing programs for deployed strategic missile systems and would carry experimental payloads. The payloads would be various types of instrumentation and equipment and would include no warheads.

Flight safety plans would be written for reentry vehicle programs to specify the technical requirements for the Kwajalein Range Safety System and warning message, evacuation, shelter, and surveillance requirements. Reentry vehicle missions that have points of impact in the mid-atoll corridor would require sheltering on Meck and Ennylabegan. Payloads that impact in the mid-atoll corridor would be

recovered from the lagoon or land impact areas. Missions with a BOA point of impact would require the implementation of existing range safety measures that would include clearance of aircraft and ships from the caution area.

North Pacific Ocean

The GSTS program would involve payloads and empty missile cases that would impact in the BOA, similar to reentry vehicle payloads launched from California and Hawaii. Flight safety plans would be implemented to protect inhabited islands, and aircraft and ship traffic. As in other programs, mitigation measures would consist of current safety procedures that have proven to be successful in past test flight programs.

The ERIS, HEDI, and SBI programs consist of test flight missions of interceptor missiles. For the first two programs, the target missiles would be launched from California or Hawaii and, for the SBI program, the target missiles would be launched from Roi-Namur. The interceptor missions, such as ERIS, would produce a much larger debris footprint, as shown in Figure 4.14-1, as a result of the collision of the interceptor and target. Appropriate precautions would be taken such as evacuation or sheltering of island inhabitants, and clearing the potential debris areas of aircraft and surface vessels. The 1984 HOE interceptor mission resulted in no debris impacting on land, although sheltering on Wake Island was used as a precaution.

4.14.2.3 Change of Duration Alternative

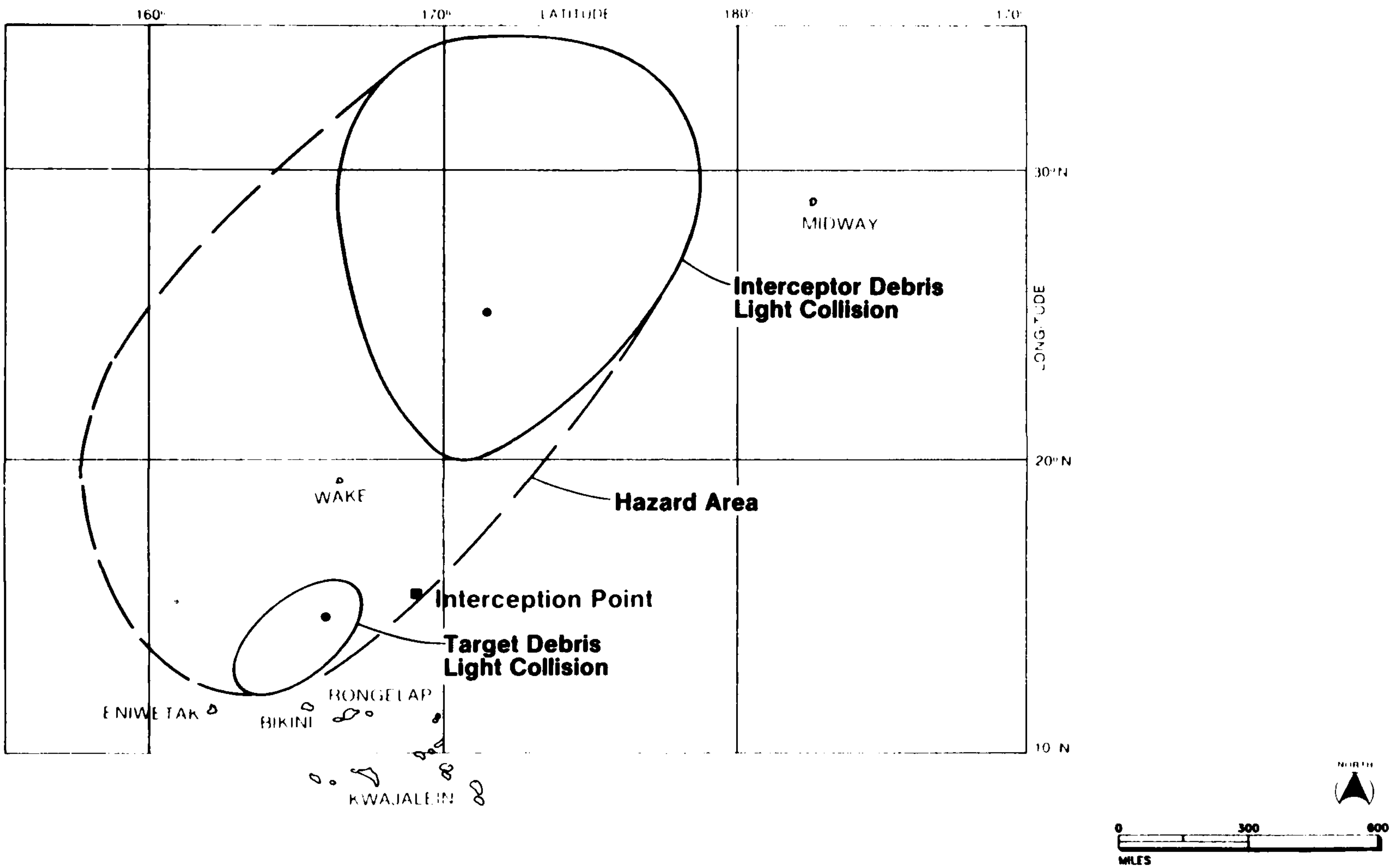
The Change of Duration Alternative would reduce the frequency of test flights and extend the duration of proposed program activities. The same safety measures would be used in the Change of Duration Alternative as those that are applicable to the Proposed Action. These measures have been successful in past test flight programs in protecting the inhabitants of the Marshall Islands, other islands, and aircraft and surface vessels.

4.14.2.4 Mitigation

No significant impacts are anticipated; therefore, no mitigation is required.

4.14.2.5 Irreversible or Irretrievable Commitment of Resources

No irreversible or irretrievable commitment of resources, or net or residual impacts would occur as a result of the Proposed Action. The areas affected by the proposed programs have experienced no adverse effects in nearly 40 years of



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INTERCEPTOR TEST FLIGHT RANGE SAFETY HAZARD AREA (PRELIMINARY, ERIS)

Figure 4.14-1

test flight operations because of strict flight safety procedures and precautionary measures.

4.15 ELECTROMAGNETIC RADIATION ENVIRONMENT

Potential Areas of Concern

The EMR environment would be affected by the Proposed Action and Change of Duration Alternative through the operation of GBR-X. Although existing radars and communications equipment would be used in support of missile launches to be conducted as a part of the Proposed Action and Change of Duration Alternative, there would be no change in the frequency of their use and there are no anticipated cumulative effects from the use of multiple radars at USAKA.

An Environmental Assessment was prepared for GBR (SDIO, March 1989), resulting in a Finding of No Significant Impact. Except where otherwise indicated, this EMR section is based on that Environmental Assessment, which is incorporated by reference.

Levels of Significance

- No or Negligible Impact. No change in EMR emissions would occur that requires any change in normal USAKA operations or that would increase levels of exposure to EMR above current levels.

- Insignificant Impact. Changes in EMR emissions require minimal changes in normal operations at USAKA; there would be no changes in the levels of exposure to EMR that would potentially affect human safety.

- Significant Impact. Changes in EMR exposure would require more than minimal changes in normal USAKA operations and could potentially affect human safety (e.g., EMR exposure exceeds 5 mW/cm^2 [32.25 mW/in^2] averaged over a 6-minute period, which is the PEL of the U.S. Army Environmental Health Agency's Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation).

4.15.1 No-Action Alternative

Under the No-Action Alternative, current EMR emissions would not change. Consequently, the EMR environment would be as it is described in Chapter 3, Section 3.15.

4.15.2 Proposed Action

Characteristics and Hazards of the Ground-Based Radar

The Ground-Based Radar (GBR) would use a pulsed microwave beam to detect and track objects. It would operate at a transmitted power much higher than that of existing USAKA radars.

The GBR would have two separate antennas mounted on the same support structure. Both would operate in the X-band of the microwave spectrum. The limited field of view (LFOV) antenna would be 10 meters (32.8 feet) square, with a 3.2-meter- (10.4-foot) diameter full field of view (FFOV) antenna at its center. The two antennas can operate as one unit through the use of phased array technology (multiple radiating elements).

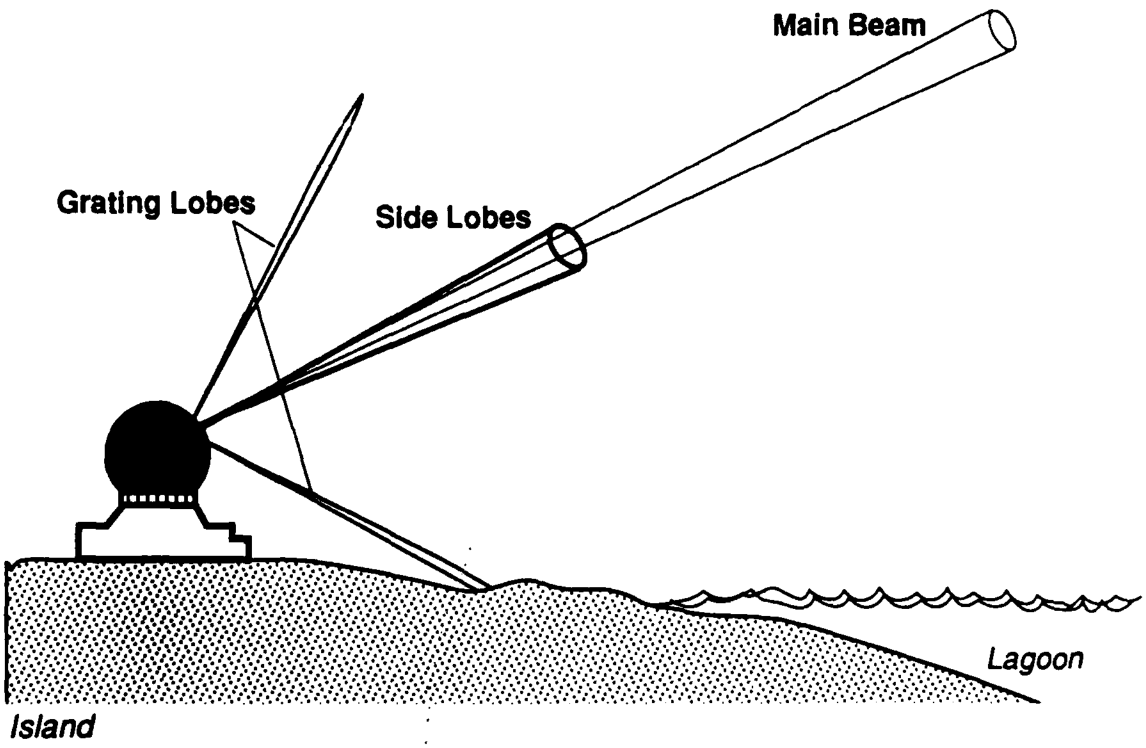
The antenna would be mounted in a spherical radome on the roof of Building 1500 on Kwajalein Island, with the antenna center 47 meters (154 feet) above the ground (see Figure 2.3-7). It would be capable of rotating in azimuths of up to 178 degrees (west to northeast) and could be inclined from 2 to 75 degrees above horizontal. Through mechanical and electronic control, the beam direction could be almost instantaneously changed.

Microwave energy would be radiated from the antenna by a main beam and secondary beams (side lobes). The design of the GBR would result in side lobes called "grating lobes." The relationship of these beams is shown in Figure 4.15-1.

The main beam would normally be operated at or above an inclination of 2 degrees. The lower edge of the area where power densities would exceed acceptable levels for human exposure (permissible power density of 5 mW/cm^2 [32.25 mW/in^2] averaged over a 6-minute period) would be well above the ground and ocean surfaces. It would increase from about 45 meters (148 feet) near the GBR to over 100 meters (328 feet) one mile away.

The GBR could be operated at inclinations of less than 2 degrees, such as when tracking RVs to splashdown. In these instances, the GBR would be restricted to using only the FFOV antenna with the average power reduced from its maximum operational 20 percent of peak power to 0.2 percent. These controls by the computer operating system would result in power densities no greater than 5 mW/cm^2 [32.25 mW/in^2] averaged over a 6-minute period from the ground surface to 6 meters (20 feet).

Theoretically, exposure to grating or side lobes of radiation could be a hazard to personnel. Grating and side lobes



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GROUND-BASED RADAR RADIATION PATTERN

Figure 4.15-1

are predictable based on a fixed set of operational conditions for a given location, but duration and incidence routinely change with the operation of the antenna. Of the two phased-array antennas used in the GBR, only the LFOV antenna irradiates the ground or sea areas around the radar with grating and side lobes. The presence of the grating lobes of the LFOV antenna necessitates a requirement for more control over possible personnel exposure. An analysis of the power densitites of the LFOV maximum grating lobe at ground/sea level near the GBR, demonstrates that it would be possible for ground/sea level power densities to reach or exceed 5 mW/cm^2 (32.25 mW/in^2) near the GBR antenna if no safety procedures were incorporated. Because of this possibility, computer-operated controls and procedures are incorporated into the GBR design to ensure that personnel are not exposed to radiation power densities exceeding 5 mW/cm^2 (32.25 mW/in^2) averaged over a 6-minute period.

Aircraft and Communications Equipment Interference

To ensure the safety of air crews and passengers, aircraft activity within a 173-mile range of the Kwajalein control tower would be coordinated with GBR testing. A Notice to Airmen would be published, advising pilots of approaching aircraft to coordinate their approaches with the tower.

An analysis has been performed by the Electromagnetic Compatibility Analysis Center to determine the potential for electronic interference results.

Other Considerations

Inadvertent detonation of rockets during arming would be controlled by adherence to DOD standards, which prescribe maximum permissible electromagnetic field intensities. Ground safety plans require silencing of radio frequency emissions prior to installing initiators and arming rockets.

Methods applied to control human exposure are also effective at avoiding fuel ignition. If necessary, GBR operations or fueling operations would be rescheduled to avoid coincidence; therefore, these potential hazards are insignificant.

4.15.3 Change of Duration Alternative

Under the Change of Duration Alternative, operations (but not construction) of the GBR-X would be delayed for 2 years and would begin in 1995. This delay in operations would have no effect on EMR other than the timing of the GBR-X emissions.

4.15.4 Mitigation

Mitigation measures identified in the GBR Environmental Assessment (SDIO, 1989) have been incorporated into the conceptual design and operating procedures for the radar, as described above. No further mitigation is required.

4.15.5 Irreversible or Irretrievable Commitment of Resources

Construction and operation of the GBR-X does not irrevocably commit the EMR environment. When the radar is not being operated, the EMR environment reverts to its previous condition.

Chapter 5
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[1] DOPAA: Description of Proposed Action and Alternatives.

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AECOS, Inc. 1988. Water Quality Sampling Study at Kwajalein and Roi-Namur Islands. U.S. Army Corps of Engineers, Honolulu Engineering District. Fort Shafter, Hawaii.

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DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

May 1, 1989

Planning Branch

Mr. Allan Marmelstein,
Pacific Island Administrator
U.S. Fish and Wildlife Service
P.O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Marmelstein:

The U.S. Army Corps of Engineers is preparing an Environmental Impact Statement (EIS) for the US Army Kwajalein Atoll (USAKA, formerly the Kwajalein Missile Range). The EIS will address both the ongoing activities of the installation as well as new activities planned as part of the Strategic Defense Initiative (SDI). Although sea turtles are known to forage and rest in Kwajalein lagoon, they do not nest on any of the islands controlled by USAKA. We, therefore, believe the activities at USAKA will not affect any listed, proposed or candidate endangered or threatened species for which U.S. Fish and Wildlife Service is responsible, and that consultation under Section 7 of the Endangered Species Act is not required. We would appreciate your concurrence with our determination.

Sincerely,

C Fung

Kisuk Cheung
Chief, Engineering Division

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS OFFICE
P.O. BOX 50167
HONOLULU, HAWAII 96850

MAY 04 1989

Mr. Kisuk Cheung
Chief, Engineering Division
U. S. Army Engineer District, Honolulu
Attention: Planning Branch
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

This responds to your May 1, 1989 request for our concurrence with your determination that Army activities at the U. S. Army Kwajalein Atoll installation will not affect any listed, proposed, or candidate endangered or threatened species of plants or animals under this Service's jurisdiction. You have reached this conclusion because no such species are found on land there.

We concur with your determination. Although listed sea turtles and cetaceans may be found in the waters surrounding the islands of the atoll, they are currently not found on shore on the islands supporting Army activities. Cetaceans and sea turtles (when in the water) fall under the jurisdiction of the National Marine Fisheries Service.

However, because listed sea turtles are known to inhabit nearshore waters around Kwajalein's islands, they may come ashore to rest or nest in the future. Should this occur and should it be determined that any Army activity may affect them in any way, the Endangered Species Act requires you to contact us.

Thank you for allowing us to comment.

Sincerely yours,

Ernest Kosaka

Ernest Kosaka
Field Office Supervisor
Office of Environmental Services

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

April 28, 1989

Planning Branch

Mr. Doyle E. Gates, Administrator
Western Pacific Program Office
2570 Dole Street
Honolulu, Hawaii 96822-2396

Dear Mr. Gates:

The U.S. Army Corps of Engineers is preparing an Environmental Impact Statement (EIS) for the US Army Kwajalein Atoll (USAKA, formerly the Kwajalein Missile Range). The EIS will address both the ongoing activities of the installation as well as new activities planned as part of the Strategic Defense Initiative (SDI). Although sea turtles are known to forage and rest in Kwajalein lagoon, they do not nest on any of the islands controlled by USAKA. None of the programmed activities will be significantly different than the activities which have occurred at Kwajalein in the past. We,therefore,believe the activities at USAKA will not affect any listed, proposed or candidate endangered or threatened species for which NMFS is responsible, and that consultation under Section 7 of the Endangered Species Act is not required. We would appreciate your concurrence with our determination.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
300 South Ferry Street
Terminal Island, CA 90731

May 18, 1989 F/SWR14:ETN

Mr. Kisuk Cheung
Chief, Engineering Division
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

This responds to your letter of April 28, 1989 regarding preparation of an Environmental Impact Statement (EIS) for the U.S. Army Kwajalein Atoll (USAKA) and new activities proposed under the Strategic Defense Initiative (SDI). Your letter indicates that although sea turtles are known to rest and forage at Kwajalein Atoll they do not nest on any of the islands controlled by USAKA. We have reviewed survey reports produced by the U.S. Fish and Wildlife Service and the University of Hawaii Sea Grant Extension Service for the Corps of Engineers regarding the natural resouces of Kwajalein Atoll, and previous documentation of sea turtle occurrence there. Based on our evaluation of the available information we concur with your determination that activities proposed for the USAKA islands will not likely to adversely affect threatened green turtles (Chelonia mydas) or endangered hawksbill turtles (Eratmochelys imbricata) at Kwajalein Atoll.

Although injury or mortality to green turtles or hawksbill turtles is unlikely, the following conditions should be included as part of the contract specifications for quarrying operations on the reef flats and the runway extension at Roi-Namur to minimize the potential for any adverse impacts.

1. The runway extension areas and quarry sites should be surveyed prior to each day's operations to ensure that no turtles are present.

2. Blasting in the quarries should be restricted to the smallest practical charge sizes. If turtles are detected within 100 m of the blast site, blasting should be postponed until the turtles have departed the area.

3. Should any turtle be injured or killed during construction, blasting or quarrying, the incident must

be documented and reported to the Pacific Area Office, NOAA Fisheries, 2570 Dole Street, Honolulu, HI 96822 (Tel. 808/955-8831) within one working day of the incident.

This concludes the Section 7 consultation process for this action. Please provide a copy of the draft EIS for review to Mr. Gene Nitta, Protected Species Management Branch, Pacific Area Office, 2570 Dole Street, Honolulu, HI 96822.

Sincerely,

E.C. Fullerton

E.C. Fullerton
Regional Director

cc:
F/SWR14, Nitta

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